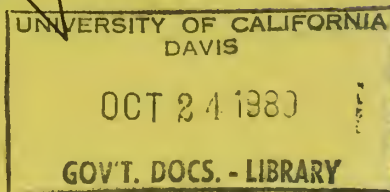


MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE PALM SPRINGS PRODUCTION-CONSUMPTION REGION

1988

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

SPECIAL REPORT 159





DIVISION OF MINES AND GEOLOGY
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SPECIAL REPORT 159

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1988

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FOREWORD

Special Report 159, "Mineral Land Classification: Aggregate Materials in the Palm Springs Production-Consumption Region," is part of the continuing analysis of aggregate resources in California to be developed by the California Department of Conservation, Division of Mines and Geology under authority of the Surface Mining and Reclamation Act of 1975 (SMARA). This classification is provided to the State Mining and Geology Board for transmittal to the local governments that regulate land use in this region, and for consideration of areas, if any, to be designated as regionally significant. SMARA was enacted by the State Legislature to assure mineral resource conservation and adequate mined land reclamation.

The Mining and Geology Board adapted guidelines in June 1978 to be employed by the Division in its mineral resource classification. This report was prepared in conformance with those directives. The undertaking is of great importance in economic geology because it deals with very specific mineral conservation issues in areas of intensive competing land use.



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PREFACE

Reserve tonnage data presented in this report was accurate as of January 1985, at which to time a preprint version of the report was circulated to lead agencies and made available the public. Changes in reserves resulting from either the premature closure of mines active in 1985, or the permitting of new mines since that time, may have impacted forecasted depletion dates for the production-consumption region studied. However, the material presented and the fundamental conclusions of the report remain valid and useful.

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CONTENTS

	Page
EXECUTIVE SUMMARY	ix
INTRODUCTION	1
Overview of Classification	1
Brief Overview of Designation	3
Overview of Aggregate Uses	3
Background and Purpose	4
DETERMINATION OF THE PALM SPRINGS P-C REGION	5
Transportation Rates	6
P-C Region Boundaries	6
ESTABLISHMENT OF THE MINERAL RESOURCE ZONES	7
Areas Classified MRZ-1	7
Areas Classified MRZ-2	7
Areas Classified MRZ-3	10
Areas Classified MRZ-4	10
EVALUATION OF PCC-GRADE AGGREGATE IN THE PALM SPRINGS P-C REGION	11
Concepts Used in Identifying Available Aggregate Resource Areas	11
Sectors	11
Calculation of Available Resources	11
Reserves and Resources	11
Factors Considered in Calculations	12
Resource Sector Descriptions	12
Lower San Geronio River — Sector A	12
Whitewater River — Sector B	12
Little Morongo Canyon — Sector C	13
Thousand Palms Area — Sector D	14
Berdoo Canyon Fan — Sector E	14
Fargo Canyon Fan — Sector F	14
Indio Hills Fan — Sector G	14
Thermal Area — Sector H	14
CLASSIFICATION OF ACTIVE MINES PRODUCING OTHER MINERAL COMMODITIES	15
ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATES	15
Basis of 50-Year Forecasts	15
Correlations between Aggregate Production and Consumption	15
Projected Population and Per Capita Consumption through the Year 2035	16
Factors Affecting Per Capita Consumption Rates	16
Comparison of the 50-Year Aggregate Demand with Current Reserves	17
ALTERNATIVE SOURCES OF AGGREGATE	19
Potential Alluvial Aggregate Sources	19
Potential Crushed Rock Sources	20
Potential Sources of PCC-Grade Aggregate Outside the P-C Region	20
CONCLUSIONS	20
ACKNOWLEDGMENTS	21
REFERENCES	21
APPENDIX	23
Interim Criteria for Sectorization of MRZ-2 Areas for Aggregate	23

TABLES

	Page
Table 1. Minimum rates for transport of aggregate in the Palm Springs area	6
Table 2. Lead agencies within the Palm Springs P-C Region	6
Table 3. Aggregate resources in the Palm Springs P-C Region	13
Table 4. Population, aggregate consumption and per capita consumption in the Palm Springs P-C Region during the period 1960-1985	16
Table 5. Projected aggregate consumption to the year 2035 for the Palm Springs P-C Region	18
Table 6. Portland cement concrete aggregate production record of Riverside County for the years 1960-1985	19
Table 7. Summary of aggregate resources and 50-year demand for the Palm Springs P-C Region	19
Table 8. Transport distances from the active deposits nearest the Palm Springs P-C Region	20

FIGURES

	Page
Figure 1. General location map of the Palm Springs P-C Region	1
Figure 2. Index to quadrangles in the Palm Springs P-C Region	2
Figure 3. Whitewater River and Little Morongo Canyon areas: sketch map showing land owned or leased by aggregate companies	4
Figure 4. Indio area: sketch map showing land owned or leased by aggregate companies	5
Figure 5. Thermal and Thousand Palms areas: sketch maps showing land owned or leased by aggregate companies	6
Figure 6. Quadrangle index indicating geologic maps used in classification of the Palm Springs P-C Region	8
Figure 7. Generalized geologic map of the Palm Springs P-C Region	9
Figure 8. Columnar section of geologic units in the Palm Springs P-C Region	10
Figure 9. Palm Springs P-C Region: Population and aggregate production record, 1960-1984	17
Figure 10. Annual per capita consumption of aggregate in the Palm Springs P-C Region	17
Figure 11. Projected population of the Palm Springs P-C Region	18

PLATES

In pocket	
Plate 1. Palm Springs P-C Region	Plate 16. La Quinta Quadrangle
	Plate 17. Indio Quadrangle
	Plate 18. Thermal Canyon Quadrangle
	Plate 19. Martinez Mountain Quadrangle
	Plate 20. Valerie Quadrangle
	Plate 21. Mecca Quadrangle
 Mineral Land Classification Maps	
Plate 2. Calclaw Flat Quadrangle	
Plate 3. Morongo Valley Quadrangle	
Plate 4. Cabazon Quadrangle	
Plate 5. Whitewater Quadrangle	
Plate 6. Desert Hot Springs Quadrangle	
Plate 7. Seven Palms Valley Quadrangle	
Plate 8. Thousand Palms Quadrangle NE 1/4	
Plate 9. Lost Horse Mountain Quadrangle NW 1/4	
Plate 10. Palm Springs Quadrangle	
Plate 11. Cathedral City Quadrangle	
Plate 12. Myoma Quadrangle	
Plate 13. Lost Horse Mountain Quadrangle SW 1/4	
Plate 14. Lost Horse Mountain Quadrangle SE 1/4	
Plate 15. Rancho Mirage Quadrangle	
	Resource Sector Maps
	Plate 22. Cabazon Quadrangle
	Plate 23. Whitewater Quadrangle
	Plate 24. Desert Hot Springs Quadrangle
	Plate 25. Palm Springs Quadrangle
	Plate 26. Cathedral City Quadrangle
	Plate 27. Myoma Quadrangle
	Plate 28. Lost Horse Mountain Quadrangle SW 1/4
	Plate 29. Lost Horse Mountain Quadrangle SE 1/4
	Plate 30. Indio Quadrangle
	Plate 31. Thermal Canyon Quadrangle

EXECUTIVE SUMMARY

This report presents the results of the classification of aggregate resources by the Division of Mines and Geology (DMG) in the Palm Springs Production-Consumption (P-C) Region. The primary goals of the study were:

1. to delineate all land within the P-C region containing sand and gravel deposits suitable for production as high-quality, Portland cement concrete (PCC) aggregate;
2. to calculate the quantity of the resources in these deposits that are on lands considered by the State to be available for possible aggregate production based upon evaluation of land uses; and
3. to evaluate the adequacy of the current aggregate reserves (aggregate resources on land permitted for mining by local government) for meeting the future needs of the P-C region.

In the Palm Springs area, as in any rapidly urbanizing area, it is important that land-use decisions are made with full recognition of the natural resources of the area. This is especially true when the resource in question is high-grade construction aggregate, an indispensable building material which is costly to transport.

The Palm Springs area contains adequate quantities of low-cost, high-quality aggregate materials. However, the amount of this material is diminishing as active aggregate producers deplete their deposits and land containing suitable sand and gravel resources is utilized for urban development.

The loss of regionally significant mineral deposits to land uses that preclude mining is one of the problems that the California Surface Mining and Reclamation Act of 1975 (SMARA) was framed to address. SMARA mandates a two-phased mineral resource conservation process called classification-designation. The objective of the classification-designation process is to provide information on future resource availability to the urban population centers which depend upon it for future growth. It is hoped that this information will provide a context for land-use decisions by local government within which mineral resource availability is acknowledged as a pertinent factor.

The DMG is responsible under SMARA for carrying out the classification phase of the classification-designation process. Classification of land for aggregate resources in the Palm Springs area is presented in this report. The State Mining and Geology Board (the Board) is responsible for the second phase of SMARA. In this phase, the Board may designate areas within a P-C Region that contain significant deposits of PCC-grade aggregate that may be needed to meet the region's future demand. The Board's decision to designate an area is based upon information in the classification report prepared by DMG and input received from lead agencies and the public. Through designation, the Board provides formal recognition of regionally significant deposits of aggregate resources.

As with any forecast of economic activity, the projections in this report should not be viewed as offering unqualified predictions of how the future will unfold. They are based upon the assumption that the data base is accurate, and that the development trends of the past three decades will continue into the five decades ahead.

Assuming that consumption forecasts are accurate, the following conclusions were reached:

- The consumption of aggregate resources in the Palm Springs P-C Region through the year 2035 is forecast to be 156.1 million tons, of which approximately 54 percent or 84.4 million tons must be of PCC quality.
- About 67 million tons of permitted PCC-grade reserves exist in the P-C region.
- Unless additional resources are permitted for mining, or alternative resources are utilized, total existing PCC reserves would be depleted by 2012, only 24 years from the publication of this report.

- In total, the 67 million tons of permitted PCC-grade aggregate reserves could provide only 43 percent of the anticipated consumption of all aggregate during the next 50 years.
- The expected longevity of the existing PCC reserves is based upon the assumption that mining of these reserves will continue to be permitted until the reserves are depleted.
- In excess of 3 billion tons of aggregate resources (including reserves) have been identified within the Palm Springs P-C Region.
- The Palm Springs P-C Region covers an area of 629 square miles, of which 33.8 square miles (5.4 percent of the total area) were classified MRZ-2. Only 28.2 square miles (4.5 percent of the total area) have been sectorized as having current land uses which do not preclude mining. About 1.3 square miles (0.2 percent of the total area) of the sectorized areas are currently under mining permits.
- The 28.2 square miles of sectorized lands considered in this study to be available for meeting future aggregate needs may be greater than the amount local governments consider to be available for mining. The reason for this discrepancy is that sectorized lands may have already been committed by local governments to purposes other than aggregate mining. The significance of this difference of opinion regarding availability is that the projected available resources (as defined by the Board) may be optimistic, and the problem of meeting future aggregate needs could be greater than that described in this report. It is important, therefore, that local governments promptly review the sector areas shown as available for future aggregate extraction. Local governments will then be able to verify, or amend as necessary, the conclusions reached in this report.

MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE PALM SPRINGS PRODUCTION-CONSUMPTION REGION



Figure 1. General location map of the Palm Springs Production-Consumption Region. See Plate 1 for detailed location.

INTRODUCTION

In the Palm Springs area (Figure 1 and Plate 1), as in any rapidly urbanizing area, it is important that land-use decisions are made with full recognition of the natural resources of the area. This is especially true when the resource in question is high-grade construction aggregate used in Portland cement concrete. This type of aggregate is an indispensable building material and is costly to transport.

The Palm Springs area contains adequate quantities of low-cost, high-quality aggregate materials. However, the amount of these materials available for future development is diminishing as active aggregate producers deplete their deposits and land containing suitable sand and gravel resources is utilized for urban development.

The loss of access to regionally significant mineral deposits as a result of land uses that preclude mining is one of the problems that the California Surface Mining and Reclamation Act of 1975

(SMARA) was framed to address. SMARA mandates a two-phased mineral resource conservation process called classification-designation. The objective of the classification and designation process is to ensure, through appropriate lead agency policies and procedures, that raw material is available when needed and does not become inaccessible as a result of a lack of information during land-use decision-making actions.

Overview of Classification

The DMG is responsible under SMARA for carrying out the classification phase of the classification-designation process. Classification entails seven distinct but interrelated steps. These seven steps are described below.

1. *Determination of Production-Consumption (P-C) Region Boundaries.* The boundaries of the P-C region are

drawn along the limits of the marketing area of the active aggregate operations supplying the urban center under study. The Palm Springs area was chosen for study by the State Office of Planning and Research (OPR) as an urban center anticipated to experience expansion. The marketing area of the production sites supplying the Palm Springs region was determined by interviews of aggregate operators and analysis of the transport rates set by the Public Utilities Commission (PUC).

2. Establishment of Mineral Resource Zones (MRZs). All lands within the Palm Springs P-C Region are assigned Mineral Resource Zone classifications (MRZ-1, MRZ-2, or MRZ-3) based upon a geologic appraisal of the aggregate

resource potential of the land. This mineral land classification is presented on Plates 2-21; Figure 2 is an index map showing the coverage of the plates in the P-C region. This appraisal includes study of pertinent geologic reports and maps, field investigation and sampling at outcrops and at active and inactive pits and quarries, and analysis of water-well logs and drill records.

3. Identification of Available Aggregate Deposits as Sectors. Lands containing significant deposits of PCC-grade sand and gravel (areas classified as MRZ-2 in step 2) are evaluated to determine whether or not current uses of these lands preclude possible future mining. Areas currently permitted for mining and areas found to have land uses com-

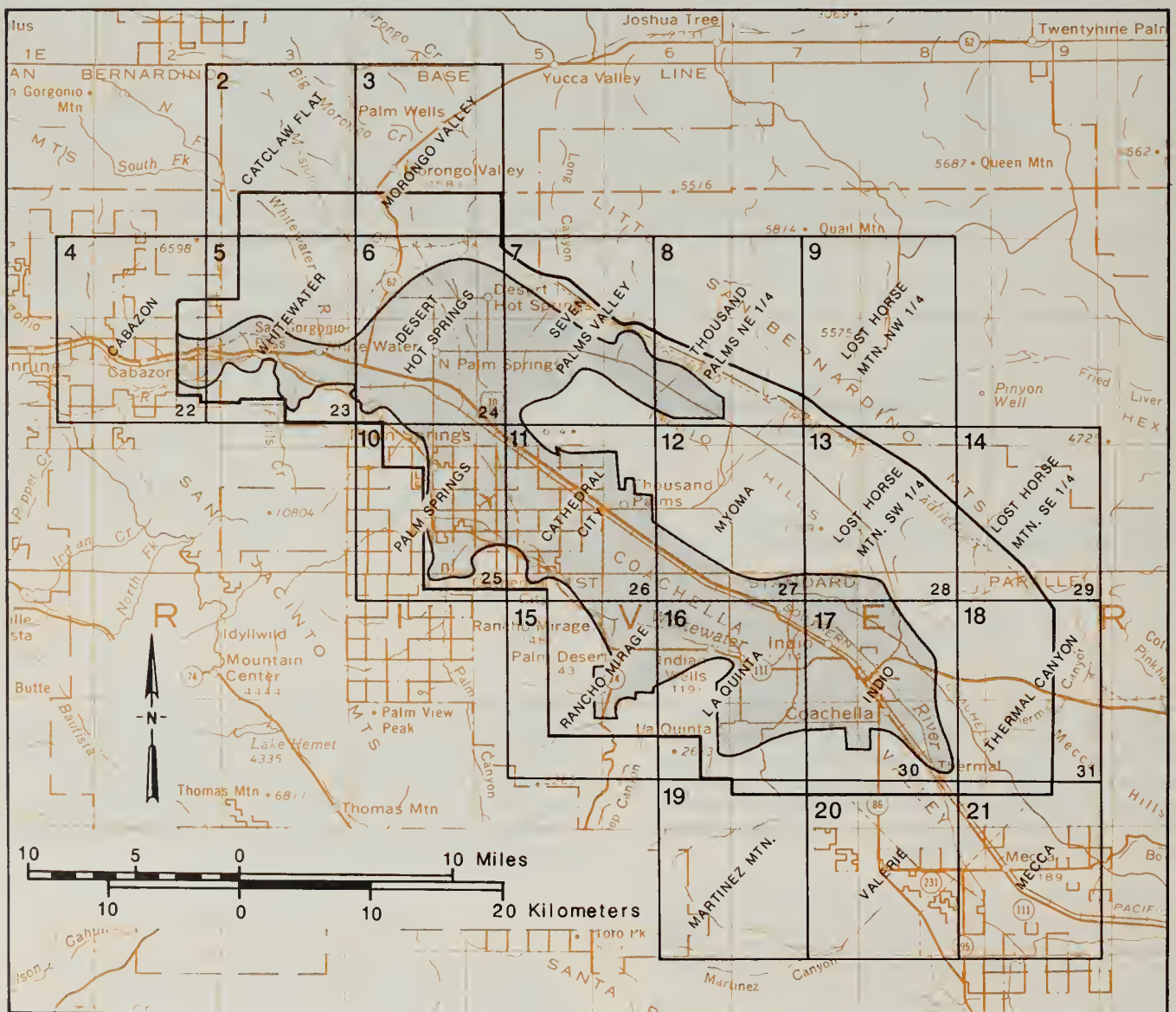


Figure 2. Index map of U.S. Geological Survey 7 1/2' quadrangles (Thousand Palms NE 1/4, Lost Horse Mountain. NW 1/4, SW 1/4, and SE 1/4 are enlarged from 15' quadrangles) covering the Palm Springs P-C Region. The Mineral Land Classification Maps (plates 2-21) are indicated by plate numbers in the upper left corners; the Aggregate Resource Sector Maps (Plates 22-31) are indicated by underlined quadrangle names and plate numbers in the lower right corners. Urbanized and urbanizing areas of the P-C region are shown with a stippled pattern.

patible with possible future mining are considered available for mining. MRZ-2 areas which are not yet developed, but which have Specific Plans approved were not considered available. Sectors which identify available land are delineated on Plates 22-31 and described in detail. An index of the plates is shown in figure 2. Criteria for sectorization of MRZ-2 areas, established by the Board, are given in Appendix 1.

4. Calculation of Resource Tonnages within Sectors.

Investigation and analysis of on-site conditions, measurement of the areal extent of deposits, drill-hole information, waste-material percentages, and deposit densities are used to calculate total tonnages of PCC-grade aggregate *reserves* (deposits in land owned or leased by an aggregate producer and permitted for mining by local government in 1986) and *resources* (all deposits of PCC quality, including the reserves) within each sector. Calculations reflect conditions of the deposits in 1986 and accommodate reserve depletion through the end of 1985.

5. *Forecast of 50-Year Needs and the Life Expectancy of Current Reserves.* The total tonnage of aggregate needed to satisfy demand in the Palm Springs P-C Region over the next 50 years is estimated based on a comparison of the projected population over that period with the average annual per capita rate of aggregate consumption from 1960-1985. Even though all identified reserves are of PCC quality, other aggregate commodities are routinely produced and marketed from them. The projected life expectancy of the reserves is based on the assumption that this practice will continue. Results of this forecast are used to determine the life expectancy of the P-C region's current reserves.

6. *Identification of Alternative Resources.* Alternative sources of aggregate to meet the forecast 50-year demand are identified and briefly considered.

7. *Other Commodities.* Active mines, where commodities other than PCC-grade aggregate are produced, are located and classified MRZ-2 if they meet the minimum threshold value set by the State Mining and Geology Board. Resources at the site are not quantified beyond confirming this minimum value. Only individual sites are classified where a mineral resource is being commercially extracted, not the entire P-C region.

Brief Overview of Designation

The present report is concerned with the classification phase of the two-step process mandated by SMARA. The designation phase follows receipt and acceptance of this classification report by the State Mining and Geology Board. Based upon the sector descriptions provided by the DMG and input from local lead agencies and the public, the Board may adopt regulations which "designate" certain mineral resource deposits as being regionally significant to satisfy future needs. Such designation, if made, would be included as part of state policy.

Overview of Aggregate Uses

Sand, gravel, and crushed stone are "construction materials." These commodities, collectively referred to as aggregate, provide

bulk and strength to Portland cement concrete, asphaltic concrete, and plaster, and stucco. Aggregate is also used as road base, subbase, railroad ballast and fill. Aggregate normally provides from 80 to 100 percent of the material volume in the above uses.

Aggregate material is essential to the needs of a modern society. It is a resource of great importance to the economy of any metropolitan area.

In this aggregate resource classification study, special emphasis is given to aggregate that meets the specifications used in making Portland cement concrete. The material specifications for PCC-grade aggregate are more restrictive than the specifications for aggregate for other applications. The restrictiveness of these specifications makes deposits acceptable for use as PCC aggregate the scarcest and most valuable of aggregate resources. This also means that aggregate produced from such deposits can be and is commonly used in other applications than concrete. Because of its versatility, value, importance in construction and relative scarcity, PCC-grade aggregate deposits are of the most concern when planning for the future availability of aggregate commodities.

Even from the highest-grade deposits, in-place aggregate raw material is rarely physically or chemically suited for every type of aggregate use. Every potential deposit must be tested to determine how much of its material can meet specifications for a particular use, and what processing is required. Specifications for various uses of aggregate material have been established by several agencies, such as the U.S. Bureau of Reclamation, the U.S. Army Corps of Engineers, and the California Department of Transportation (Caltrans), to ensure that aggregate is satisfactory for specific uses. These agencies, and other major consumers of concrete, test aggregate for acceptance by standard test procedures outlined by such organizations as the American Society for Testing Materials and the American Association of State Highway Officials.

Most aggregate specifications have been established to ensure the manufacture of strong, durable materials capable of withstanding the physical and chemical effects of weather and use. For example, specifications for Portland cement concrete and concrete products prohibit or limit the use of rock materials containing mineral substances such as gypsum, zeolites, pyrite, opal, chalcedony, chert, siliceous shale, volcanic glass, and some high-silica volcanic rocks. Gypsum shortens the setting time of Portland cement, pyrite dissociates to yield sulfuric acid and iron oxide stain, and other substances contain silica in a form that reacts with alkali substances in the cement, resulting in cracks and "pop-outs."

Specifications also call for precise particle-size distributions for the various uses of aggregate. Aggregate is commonly classified into two general sizes — coarse aggregate and fine aggregate. Coarse aggregate is rock retained on a 3/8" or a #4 U.S. sieve. Fine aggregate passes a 3/8" sieve and is retained on a #200 U.S. sieve (a sieve with 200 weaves per inch). For some uses, such as asphalt paving, particle shape is specified. Caltrans' Standard Specifications (1981) require that at least 25 percent by weight of coarse aggregate (1/4 inch to 3/4 inch diameter) used as Class 2 aggregate base material shall be crushed particles. Furthermore, aggregate material used with bituminous binder to form sealing coats on road surfaces shall consist of at least 90 percent by weight of crushed particles. Crushed stone is

preferable to natural gravel in asphaltic concrete because asphalt adheres better to broken surfaces than to rounded surfaces, and the interlocking of angular particles strengthens the asphaltic concrete and road base.

The preferred use of one aggregate material over another in construction practices depends not only on specification standards but also on economic considerations. Alluvial gravel is preferred to crushed stone for Portland cement concrete aggregate because the rounded particles of alluvial sand and gravel result in a wet mix that is easier to work than a mix composed of angular fragments. The workability of a mix consisting of Portland cement with crushed stone aggregate can be improved by adding more sand, water and cement to maintain concrete durability standards. At the present time, the additional cement amounts to about a quarter of a 94 pound sack per cubic yard of concrete at an additional cost of about \$1.00 per yard of mix. Although more care is required in pouring and placing wet mix containing crushed stone, Portland cement concrete made with this aggregate is as satisfactory as that made with alluvial sand and gravel of comparable rock quality.

In the Palm Springs area, PCC aggregate sells in bulk for about \$4.00 per ton at the plant site (in 1986). However, this selling price reflects only part of the costs to the consumer. Transport costs are a significant part of the final delivery price. In areas that lack nearby aggregate sources, the delivery charges alone may be greater than the sale price of the material at the plant site.

Background and Purpose

Urban expansion has been a major contributing factor to the loss of significant mineral resources in California in past years. In response to the problem of conflicting land use, the need for essential mineral products and for information concerning their location and quantity, the California State Legislature enacted the Surface Mining and Reclamation Act of 1975 (SMARA). SMARA requires the State Geologist to classify,* according to the presence or absence of significant mineral deposits, certain areas of the state which are subject to urban expansion or other irreversible land uses incompatible with mining. Urbanizing areas are identified by the State Office of Planning and Research (OPR). The boundaries of the areas are modified to reflect current land use through consultation with local lead agencies and selected on-site field inspection.

The State Mining and Geology Board, upon receipt of the classification information from the State Geologist, transmits the classification report to the appropriate lead agencies and makes it available to other interested parties. Within twelve months of receipt of the classification report, each lead agency must develop and adopt mineral resource management policies to be incorporated in its general plan. These policies will:

1. Recognize the mineral classification information, including the classification maps, transmitted to it by the Board, and
2. Emphasize the conservation and development of identified mineral deposits.

*Classification is the process of identification of lands containing significant mineral deposits based solely on geologic factors, and without regard for present land use or land ownership.

After receipt of mineral classification information from the State Geologist, the State Mining and Geology Board may designate specific geographic areas that contain mineral deposits of regional significance. Procedures for the designation** of lands containing significant mineral deposits are specified in Section II.2 of the State Mining and Geology Board's "Guidelines for Classification and Designation of Mineral Lands," which is included as Part II of California Division of Mines and Geology Special Publication 51, "California Surface Mining and Reclamation Policies and Procedures" (1983). This publication is available from the Division of Mines and Geology free of charge.

The "Guidelines for Classification and Designation of Mineral Lands" were adopted by the State Mining and Geology Board on June 30, 1978. The purpose of the guidelines is to implement SMARA by providing direction to the State Geologist in carrying out mineral resource classification, and to establish procedures by which the Board may designate mineral-bearing lands of statewide or regional significance. Section 1.1.a of the guidelines requires that the State Geologist classify specified areas into *Mineral Resource Zones (MRZs)* or *Scientific Resource Zones (SZs)* as defined in Section 1.2 of the guidelines. Although California has a wide range of mineral commodities within its borders, the Mining and Geology Board recognizes that construction materials (sand, gravel, and crushed stone) are

** Designation is the formal recognition by the State Mining and Geology Board, after consultation with lead agencies and other interested parties, of areas containing mineral deposits of regional or statewide significance that should be considered for protection from land uses incompatible with mineral extraction. These deposits are deemed to be of prime importance in meeting the future needs of the region or the state.

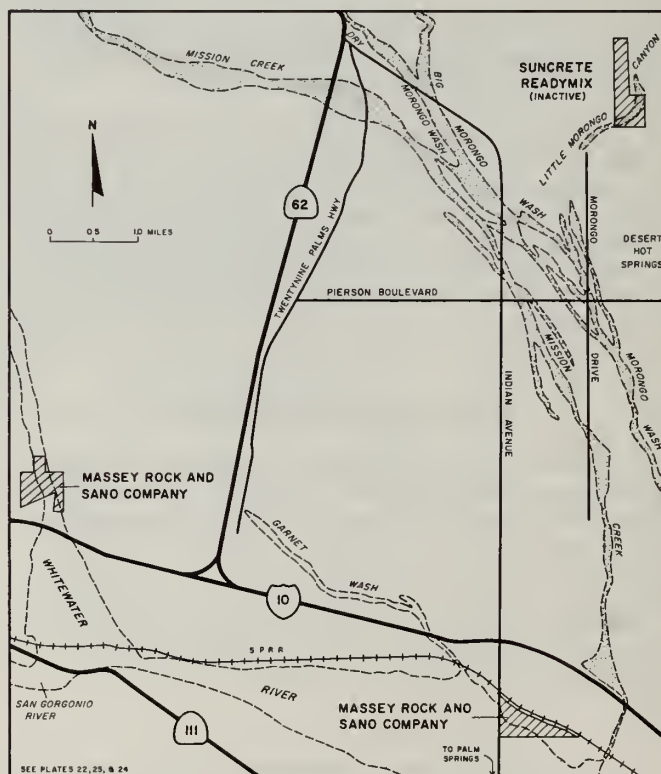


Figure 3. Whitewater River and Little Maranga Canyon areas: Sketch map showing land owned or leased by aggregate companies.

produced regionally, are used in every urban area of the state, and require special classification data. Section 1.3 of the guidelines requires that classification reports that pertain to deposits of construction materials include the following information: (1) the location and estimated total quantity of construction material that is geologically available for mining; (2) limits of the market (production-consumption) region which the potential resource would serve; and (3) an estimate of the total quantity of material that will be needed to supply the requirements of the consumption region for the next 50 years. This information will assist the State Mining and Geology Board in determining the statewide or regional significance of these types of deposits.

The Mineral Land Classification of the Palm Springs Production-Consumption Region was initiated in 1985 by the State Geologist. Portland cement concrete-grade aggregate resources of the area were selected for initial classification.

Each PCC-grade aggregate deposit was evaluated separately, and then considered as part of a single production-consumption (P-C) region established on the basis of existing aggregate consumption patterns. The Palm Springs marketing region is served by several production areas with overlapping market regions: the Whitewater River area, the Indio area, the Thermal area, and the Thousand Palms area (Figures 3, 4 and 5).

DETERMINATION OF THE PALM SPRINGS PRODUCTION-CONSUMPTION REGION

Because the Palm Springs area was targeted by the Office of Planning and Research as an area experiencing significant urban expansion (OPR, 1975), the State Mining and Geology Board scheduled it for an aggregate study by the Division of Mines and Geology. To determine the aerial limits of such a study, the Division must accommodate several factors. Ideally, both the production zones and 95 to 100 percent of the areas served by these zones are included in the study. Usually this more than encircles the area identified by the OPR as that anticipated to be urbanized by 1990. This is the case in the Palm Springs area.

A study of sand and gravel production and consumption of the region showed that over 99 percent of the aggregate produced in the P-C region is used in the urbanizing portions of the Upper Coachella Valley, from Thermal in the south to Palm Springs in the north. However, the amount of aggregate imported from the San Geronio River area which is within the neighboring San Bernardino P-C Region, near the City of Banning, has increased substantially since 1980. In 1986, it exceeded 10 percent of the total consumption of the Palm Springs P-C Region.

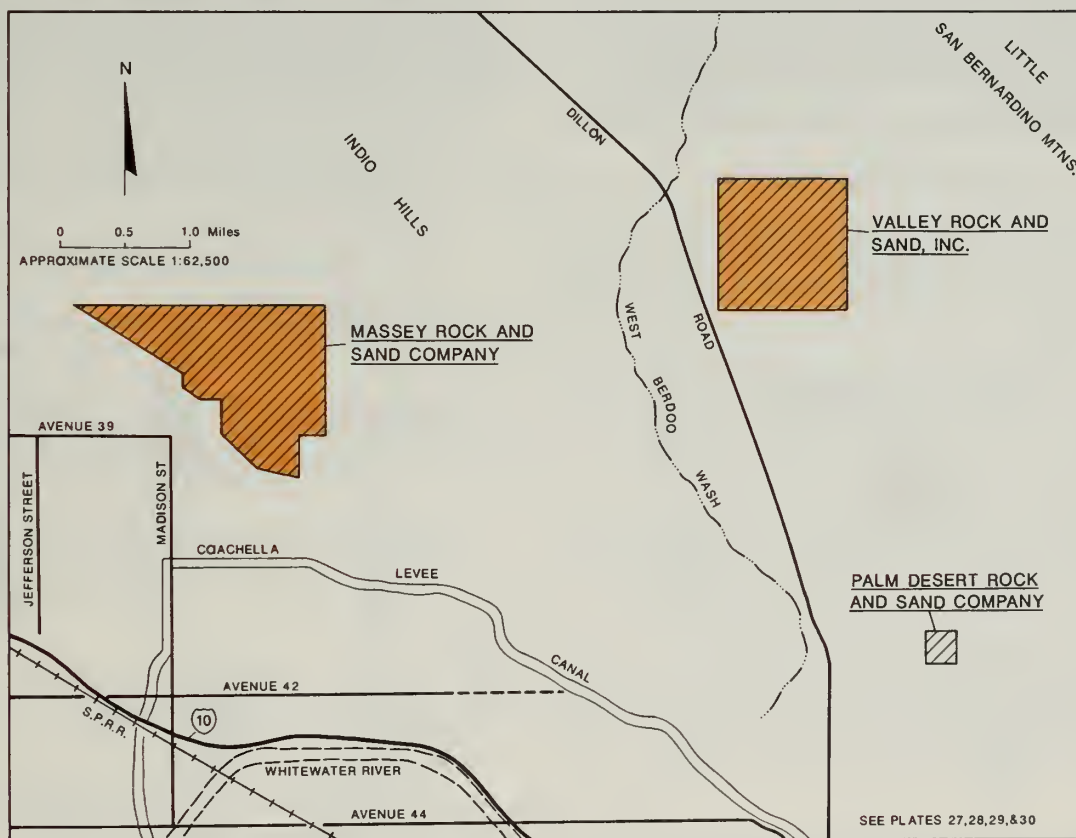


Figure 4. Indio area: Sketch map showing land owned or leased by aggregate companies.

Transportation Rates

Because aggregate is a low-value, high-bulk-weight commodity, a major part of its cost to the consumer is for transportation. In fact, transport costs are one of the major constraints on the marketing area for a production district.

All aggregate marketed in the Palm Springs P-C Region is transported by truck. Minimum rates for independent aggregate truckers are set by the California Public Utilities Commission. Rates for the Coachella Valley are published in "Minimum Rate Tariff 7-A." Charges are calculated based on either an hourly rate or a distance rate. If the hourly rate is used, the carrier and consumer must enter into a written agreement prior to transport.

TABLE 1. Minimum rates for transport of aggregate in the Palm Springs area*. From California Public Utilities Commission, 1987, Minimum Rate Tariff 7-A.

DISTANCE RATE ** (for selected increments)		HOURLY RATES ***	
Miles	Rates (\$/ton)	# of Axles per Unit of Equipment	Rate (\$)
5	1.22	2	42.23
10	1.84		
15	2.42	3	47.90
20	3.00		
25	3.56	4	50.47
30	4.09		
35	4.61	5 +	53.33
40	5.15		

*The minimum hourly rate or the minimum distance rate, whichever is larger, may be charged to the consumer.

**Rates are higher for work done on holidays or weekends and if equipment other than a "tractor with bottom dump doubles in train" are required at the destination.

***Requires on agreement between carrier and consumer. Rates are higher for work done on holidays and weekends.

Table 2. Lead agencies (county and incorporated city governments) located within the Palm Springs P-C Region.

AGENCIES	
COUNTIES	CITIES
Riverside* + †	Coachella
	Desert Hot Springs
	Indian Wells
	Indio
	Palm Desert
	Palm Springs +
	Rancho Mirage

*Agencies with active aggregate operations within their jurisdictional boundaries.

+ Agencies that have land classified MRZ-2 within their jurisdictions.

†Lead agencies containing sectors.

The cost of transporting a ton of aggregate by truck to the City of Palm Springs from the nearest plant at Garnet, about 7 miles, is \$1.47, based on the PUC rates. The minimum transportation cost of delivering aggregate to Palm Springs from more distant plants is based on the PUC rates listed in Table 1. For instance, the added cost for a normal 24-ton truck and trailer load from the Indio area to Palm Springs, which is about 20 miles, would be \$3.00 per ton.

P-C Region Boundaries

The Production-Consumption Region (Plate 1) was delineated to encompass: (1) the entire metropolitan areas of Palm Springs, Desert Hot Springs, La Quinta, Palm Desert, Rancho Mirage, Indian Wells, Indio, and Coachella and surrounding areas anticipated by the OPR and/or the local cities and the County of Riverside to urbanize in the next 10 to 30 years (Plate 1);

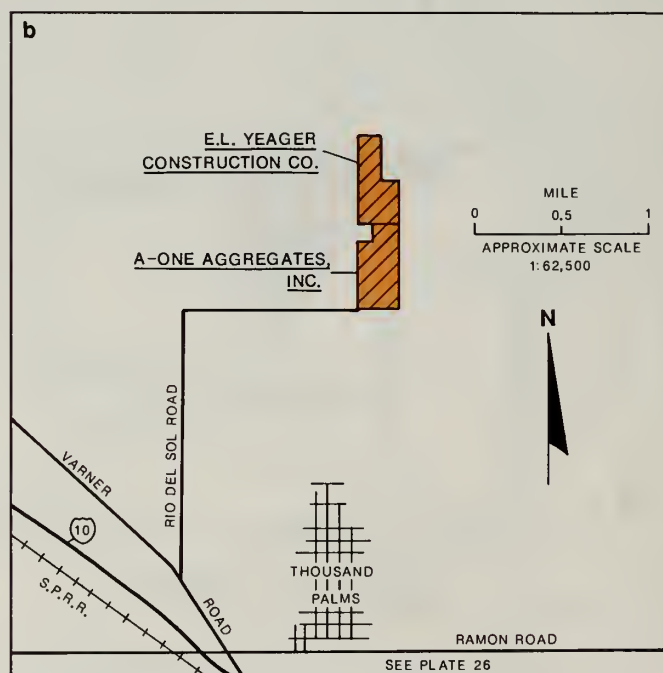
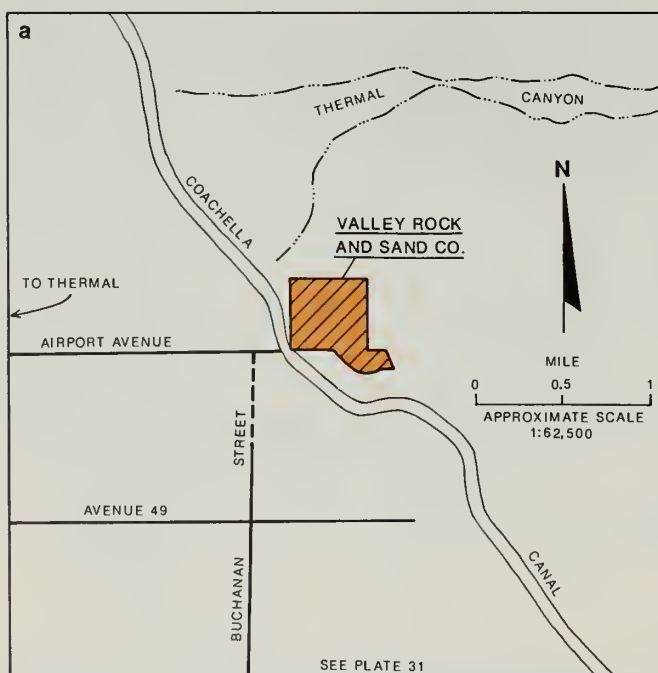


Figure 5. Thermal (a) and Thousand Palms (b) areas: Sketch maps showing land owned or leased by aggregate companies.

2) outlying communities such as North Palm Springs, Desert Haven, Sky Valley, Rimlon, Cathedral City, Thousand Palms, Bermuda Dunes, and Thermal; 3) rural areas not anticipated to urbanize but which are sparsely populated and consume aggregate

from the production areas of the region; and 4) the four current production areas and a fifth inactive production area north of Desert Hot Springs. Lead agencies with jurisdiction within the P-C region are shown on Table 2.

ESTABLISHMENT OF MINERAL RESOURCE ZONES

The DMG has classified land in the Palm Springs P-C Region according to the presence or absence of significant PCC-grade aggregate deposits. The land classification is presented in the form of Mineral Resource Zones. Directions for the identification of Mineral Resource Zones are set forth in DMG's Special Publication 51 in the section entitled "Guidelines for Classification and Designation of Mineral Lands" (California Division of Mines and Geology, 1983).

The guidelines for establishing the Mineral Resource Zones are as follows:

MRZ-1 Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence. This zone shall be applied where well-developed lines of reasoning, based upon economic-geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is nil or slight.

MRZ-2 Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists. This zone shall be applied to known mineral deposits or where well-developed lines of reasoning, based upon economic-geologic principles and adequate data, demonstrate that the likelihood for occurrence of significant mineral deposits is high.

MRZ-3 Areas containing mineral deposits, the significance of which cannot be evaluated from available data.

MRZ-4 Areas where available information is inadequate for assignment to any other MRZ zone.

Mineral Resource Zones in the Palm Springs P-C Region are presented on twenty 1:48,000 reductions of U.S. Geological Survey topographic maps (Plates 2-21). Figure 2 shows the quadrangle maps that cover the Palm Springs area.

MRZs within the Palm Springs P-C Region were established on the basis of an aggregate appraisal that included the following tasks for assessing the quantity, quality, and extent of the aggregate deposits:

1. Examination and compilation of relevant geologic maps, aerial photos, geologic literature, aggregate industry data (some of which is proprietary) and aggregate engineering test data. The geologic maps used in classification of the Palm Springs P-C Region are indicated on Figure 6. Figure 7 shows the generalized geology of the region and Figure 8 is a columnar section of the region.
2. Interviews with aggregate plant operators.

3. Compilation and analysis of subsurface well-log data and drilling records.

4. Field investigation of rock units and active and inactive aggregate quarries.

Areas Classified MRZ-1

Areas classified as MRZ-1 were judged on the basis of available data to have little likelihood of containing significant deposits of PCC grade aggregate. Deposits that have excessive amounts of clay, silt, organic matter, absorptive rock, alkali-reactive rock, platy rock, or soft rock are unsuitable for use in PCC aggregate; areas containing such deposits are classified MRZ-1.

The areas in the Palm Springs P-C Region that are classified as MRZ-1 are underlain by older sedimentary material judged to contain too much clay and silt. This includes Quaternary alluvial deposits in the center of the Upper Coachella Valley; the Imperial Formation which crops out in the Indio Hills, Garnet Hill, and the hills west of Whitewater River Canyon; and the Borrego Formation in the southeastern corner of the region. The location of the fine-grained alluvial deposits was determined from drill logs.

Areas Classified MRZ-2*

Eight areas within the Palm Springs P-C Region are classified MRZ-2 for PCC-grade aggregate. These are areas for which data indicate that there is a high likelihood that significant deposits of PCC-grade aggregate exist.

SMARA guidelines set forth two requirements to be used to determine if land should be classified MRZ-2:

1. The deposit must be composed of material that is suitable as a marketable commodity.
2. The deposit must meet threshold value. The projected value (gross selling price) of the deposit, based on the value of the first marketable product, must be at least \$8,500,000 (which equates with 5 million 1978 dollars).

Areas classified MRZ-2 contain aggregate resources that are either proven to be of PCC grade or highly likely to be of PCC grade. Much of the aggregate in the MRZ-2 areas has not been identified as PCC grade aggregate through formal engineering tests. Aggregate deposits in untested, unproven areas identified

*In addition to areas classified MRZ-2 for PCC-grade aggregate, individual mine sites of all other active mining were also classified MRZ-2 (see section on Classification of Active Mines Producing Other Mineral Commodities).

as MRZ-2 are believed to contain PCC grade aggregate for either of the following reasons:

- The aggregate in unproven areas is similar in age and lithology, and was deposited under similar geologic conditions to that of the proven PCC-grade aggregate deposits.
- The unproven deposit is a lateral extension of an alluvial formation from which PCC-grade aggregate has been produced.

Areas classified MRZ-2 for PCC-grade aggregate in the Palm Springs P-C Region are underlain by Holocene river

channel and floodplain deposits and alluvial fan deposits. These areas include that part of the Whitewater River floodplain extending from the Whitewater Trout Farm to the City of Palm Springs, the San Geronio River floodplain from the P-C region boundary to its confluence with the Whitewater River, the river channel in the lower part of Little Morongo Canyon, a small alluvial wash north of Thousand Palms, the confluent alluvial fans of Berdoo and West Berdoo Canyons, the alluvial fan of Fargo Canyon, an alluvial fan north of Indio, and an alluvial wash and fan east of Thermal. Each area is discussed in detail under the resource sector descriptions.

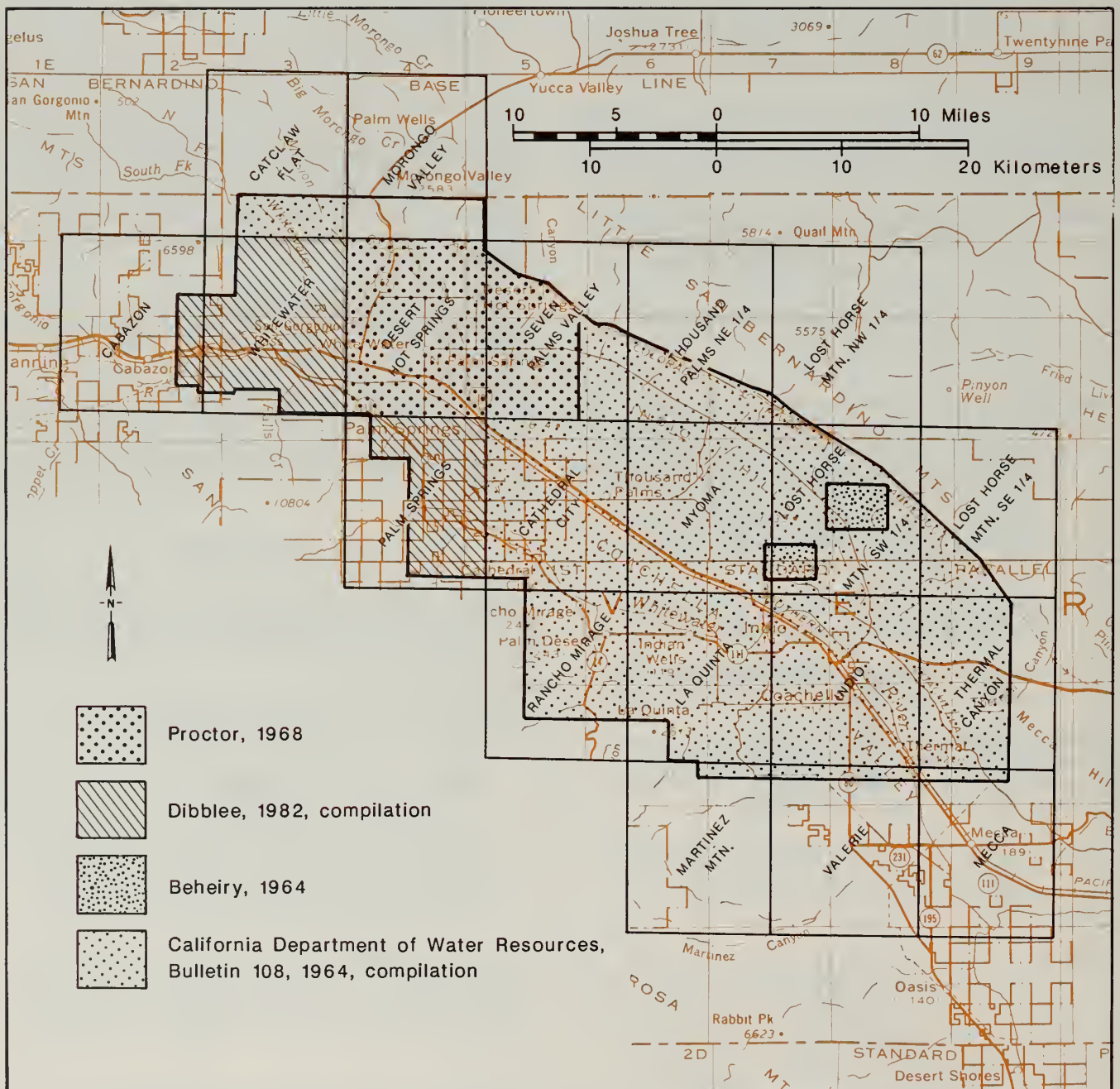


Figure 6. Quodrangle index indicating geologic maps used in classification of the Palm Springs P-C Region.

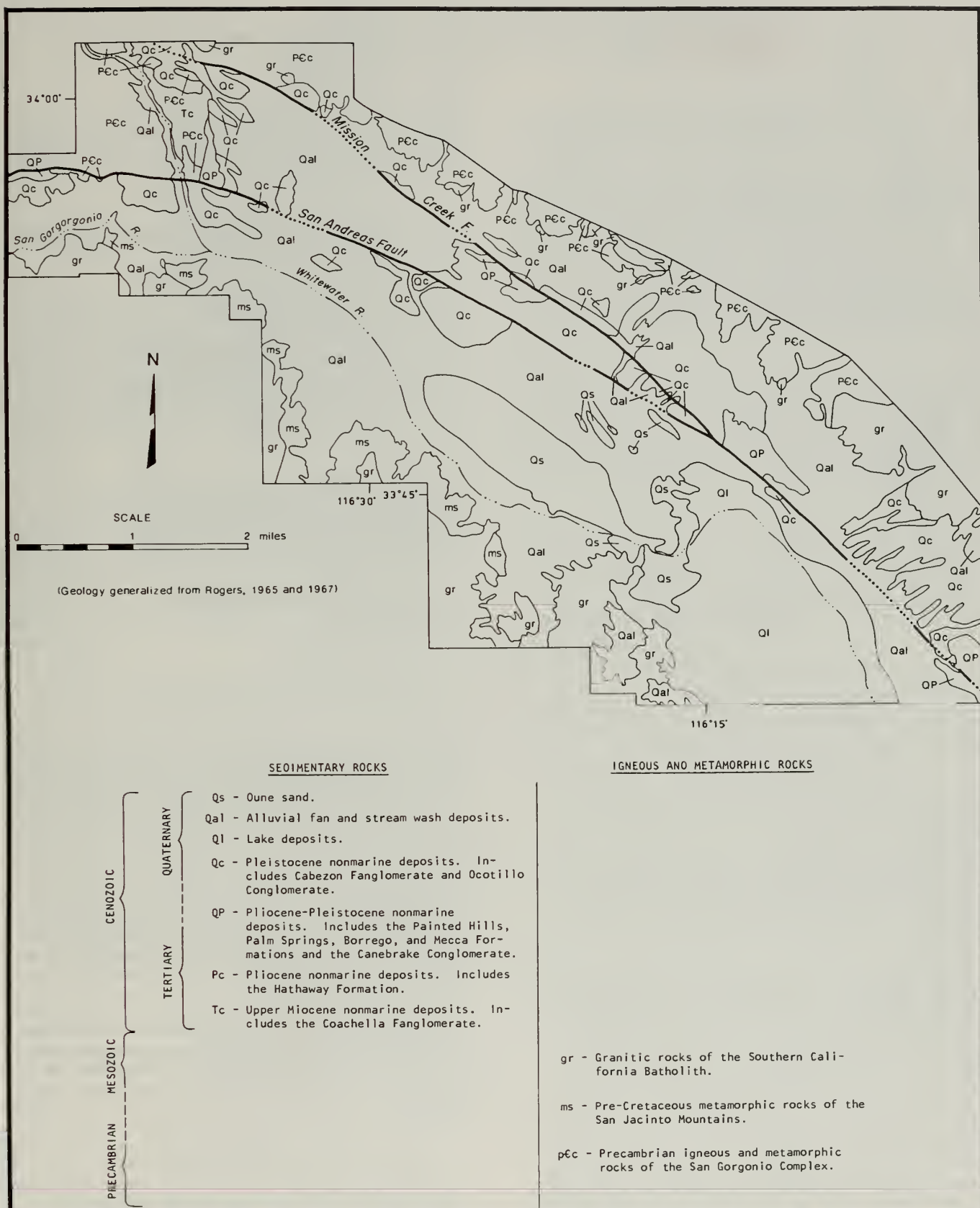


Figure 7. Generalized geologic map of the Palm Springs P-C Region.

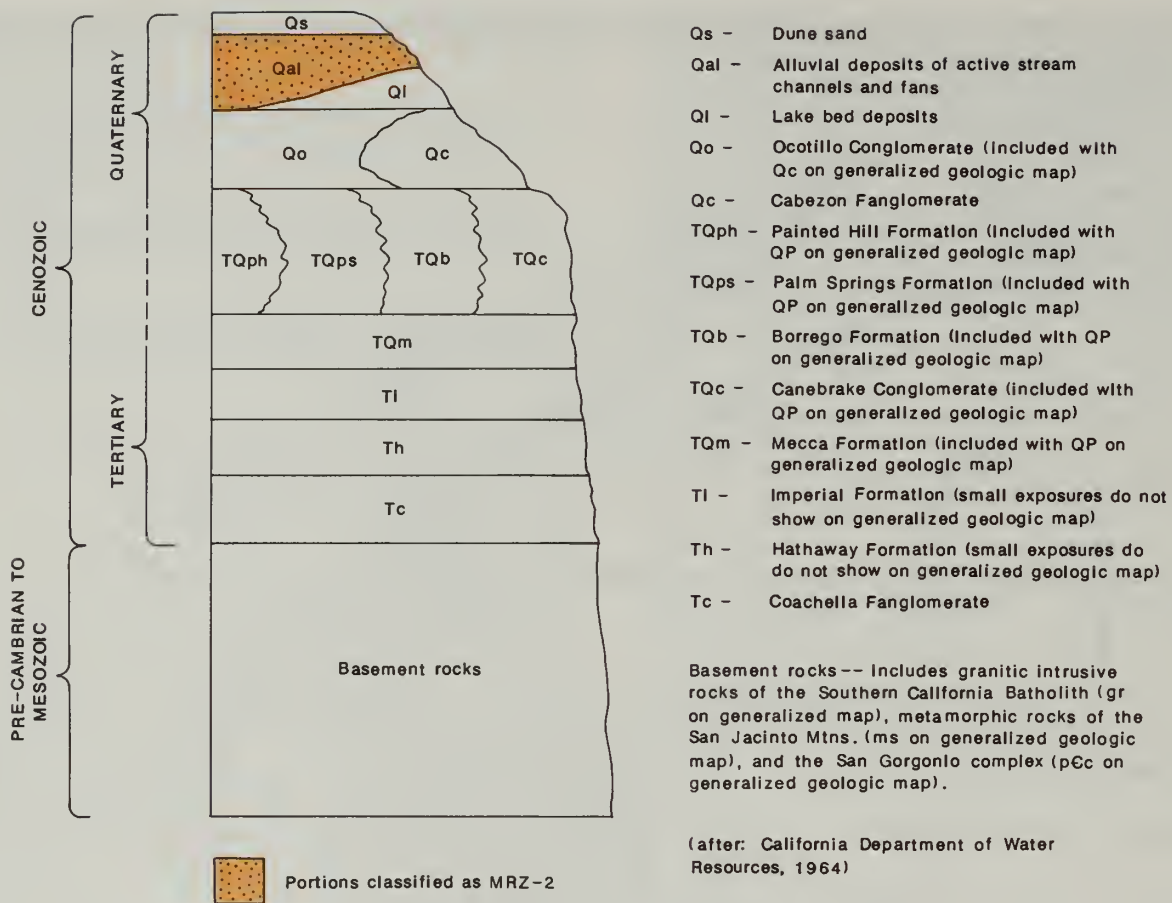


Figure 8. Columnar section of geologic units in the Palm Springs P-C Region.

Areas Classified MRZ-3

Areas classified MRZ-3 are those containing aggregate deposits, the significance of which cannot be evaluated from available data.

Hilly or mountainous areas underlain by sedimentary, metamorphic, or igneous rock types and lowland areas underlain by alluvial wash or fan material were often included in this category.

For the upland areas, indications in the geologic literature or field examinations that showed the rock unit to contain abundant, hard, durable material without excessive amounts of deleterious material were necessary for consideration for MRZ-3 classification. Additional information regarding the quality of material in these areas could either upgrade the classification to MRZ-2 or downgrade the classification to MRZ-1. Formations and rock types located within the Palm Springs P-C Region that are classified as MRZ-3 include the Cabezon Fonglomerate, the Ocotillo Conglomerate, the Painted Hills Formation, the Canebrake Conglomerate, the Palm Springs Formation, the Mecca Formation, the Hathaway Formation, the Coachella Fonglomerate, granitic rocks of the Southern California Batholith, and the metamorphic rocks of the San Jacinto Mountains and the San Geronio Complex. Figure 8 illustrates the relative stratigraphic positions and ages of these units.

A large part of the valleys and canyons are underlain by alluvial material that may be acceptable for use as PCC aggregate. This would include the washes and fans north of Palm Springs and west of Desert Hot Springs such as Mission Creek Wash and Morongo Wash; the alluvial fans between the Little San Bernardino Mountains and the Indio Hills such as Wide Canyon fan, Deception Canyon fan and Pushawalla Canyon fan; the alluvial fans along the northeastern flank of the San Jacinto Mountains such as the Chino Canyon fan, the Palm Canyon fan, and the Dead Indian Canyon fan; the small alluvial fans along the southwestern edge of the Indio Hills; and the alluvial washes and fans along the southwestern edge of the Mecca Hills such as the Thermal Canyon wash and fan.

In all areas where rock units or alluvial deposits are classified MRZ-3, test data necessary to judge the quality of the material are lacking. If some part of a deposit is not being mined or has not been mined for aggregate, then such test data are usually not available.

Areas Classified MRZ-4

Areas classified MRZ-4 are those areas for which available information is inadequate for assignment to any other MRZ category. No areas were classified MRZ-4 in the Palm Springs P-C Region.

EVALUATION OF PCC-GRADE AGGREGATE IN THE PALM SPRINGS P-C REGION

An assessment of aggregate resources in the Palm Springs P-C Region is presented in this section of the report. The assessment was conducted on the basis of a quantitative evaluation of available and suitable aggregate resources classified MRZ-2.

Concepts Used in Identifying Available Aggregate Resource Areas

The State Geologist is responsible for calculating aggregate resources for those areas classified as MRZ-2. Recognizing that there are lands within MRZ-2 areas that have already been urbanized or for which approved Specific Plans have been secured and that therefore have a limited opportunity for mineral resource conservation and extraction, the State Geologist has limited the calculation of aggregate resource tonnages to portions of MRZ-2 areas that do not have current land uses incompatible with mining.

For purposes of classification, incompatible uses are defined as improvements of high cost, such as high-density residential developments, intensive industrial developments, commercial developments, and major public facilities (see Appendix I, Interim Criteria for Sectorization of MRZ-2 Areas for Aggregate). Compatible uses are very low density residential developments (approximately one unit or less per ten acres), recreational developments of low cost, agriculture, silviculture, grazing, and open space.

For this report, the determination of which MRZ-2 land is nonurbanized was based upon conditions of the land at the time of the study (November 1985 through August 1986). The use of the land was determined by the author after consultations with lead agencies, reference to aerial photographs and photo-revised topographic maps and field reconnaissance. Lands for which Specific Plans had been approved by the lead agency were considered to be unavailable for sectorization.

SECTORS

Sectors are areas that have been classified as MRZ-2 by the State Geologist, and that are deemed to be available for mining based upon criteria for availability provided by the State Mining and Geology Board. Furthermore, within each sector the geometrical configuration of the deposit is sufficiently regular to permit reliable calculation of the tonnage of the mineral resource present. Thus, for example, sector boundaries would be established between that part of a natural deposit formed on a fan, and that part within the confines of an adjacent modern stream channel and its floodplain. Mineral land classification, which is done without regard for current land use, results in a delineation of the resource areas on maps; but this by itself does very little to put into perspective the resource base that is available to meet the future needs of a region. Sectors have been employed to focus the attention of land planners and local governments on just those areas that remain accessible for mineral extraction. The State Geologist calculates the available resources of each sector and identifies the amount of remaining resources that have been permitted for mining. These latter resources are termed reserves. The resources present in other

(non-sectorized) MRZ-2 resource areas are not calculated because they are regarded as unavailable.

The calculated reserves and resources of all the sectors of a region are compared with the State Geologist's forecast of the 50-year needs of a region for the mineral resources. The comparison of regional needs with the available reserves and resources provides the opportunity to focus attention on the mineral resource issues confronting the region; viz. the need to plan carefully for the use of any lands containing mineral resources, and the need to consider the permitting of additional mining operations in the region as currently mined deposits are depleted.

Each sector meets or exceeds the Board's threshold values for deposits of significant size, and each sector may be considered for designation as an area of regional or statewide significance by the State Mining and Geology Board pursuant to Section 2790 SMARA. Areas that have not been sectorized by the State Geologist are not considered for designation by the Board.

Although the classification by the State Geologist and the designation by the Board are actions explicitly provided for by SMARA, and the results of such actions yield reports that must be acted upon by affected local governments, the sectorization and sector maps do not by themselves carry with them specific obligations imposed on local governments by SMARA (as do the classification maps).

The sector maps and the resource base calculations, however, contain the essential facts that are needed to focus the attention of planners on the mineral availability problems and the alternative solutions to meet the mineral resource needs of the region. Without the sector maps and the accompanying calculations, the primary objectives of SMARA could not be achieved.

Because the Board's criteria for sectorization focus on the apparent suitability of the land for mining and do not take into account commitments (other than approved tracts or Specific Plans) that may have been made to restrict the accessibility of some of the sectors for mining, it is possible that the available resource base as calculated by the State Geologist may be overestimated and the problems confronting local government may be understated. Considering these possibilities, it becomes important for local governments to carefully review the sectors and the associated estimates of resources to ensure that previously unrevealed problems are not overlooked and that planning decisions are made using a correct perspective on available resources.

Calculation of Available Resources

RESERVES AND RESOURCES

In this report, *reserves* are estimates of tonnages of aggregate that have been determined to be acceptable for commercial use, that exist within properties owned or leased by aggregate producing companies, and for which permits have been granted to allow mining and processing of the material. *Resources* include *reserves* as well as all similar potentially usable aggregate mate-

rials that may be mined in the future, but for which no permit allowing mining has been granted, or for which marketability has not been established.

FACTORS CONSIDERED IN CALCULATIONS

The resource estimates given here are limited to those PCC-grade aggregate resources present in resource sectors, which are, as explained in the previous section, the nonurbanized portions of the areas classified MRZ-2. The resource sectors defined in this study are shown on the sector maps (Plates 22-31) that accompany this report.

Some sectors are subdivided into numbered subsectors to recognize the location of existing freeways, canals, bridges, major powerlines and major pipelines. This allowed for the calculation of more realistic resource tonnages.

The following factors were used to determine the areal extent and tonnage of PCC grade aggregate resources within the sectors:

1. Sector resource tonnage estimates were based on measurements taken from base maps that have a scale of 1:24,000.
2. Even in proven PCC-grade aggregate deposits, a small percentage of the aggregate cannot be used in concrete and is referred to in this study as "waste." Waste includes pit-run and production waste, both of which may be utilized in non-PCC uses. Known waste percentages were extrapolated to deposits in untested sector areas from proven, nearby PCC-grade aggregate deposits.
3. Thicknesses of PCC grade deposits were determined through the use of water-well log data and information provided by persons who have knowledge concerning aggregate deposits in this region.
4. A standard setback of 100 feet from utility and rail lines, and urban developments was used in determining the areal limits of sectors that border areas not available for mining.
5. Side slopes were calculated to have a 1:1 gradient.
6. An in-place material density of .063 tons per cubic foot was assumed in calculating alluvial resources. This value was derived from similar deposits in the San Gorgonio River and Santa Ana Wash to the west (Miller, 1983); no direct density measurements were made during this study.
7. The alluvial washes and fans in the arid Palm Springs area generally have little or no overburden. Hence, overburden was not considered as a factor.

Resource Sector Descriptions

The total area of the resource sectors in the Palm Springs Region P-C is 28.2 square miles, of which 1.3 square miles are currently permitted for mining. As previously noted, sectors are delineated only within areas classified MRZ-2 that are available for mining. The estimated total of PCC grade aggregate re-

sources in these sectors is 3.2 billion tons (Table 3). As of August 1986, 67 million tons of these resources were permitted for mining and therefore are listed as reserves. Annual depletion of reserves for 1986 (which will probably total about 2.5 million tons) has not been subtracted from this figure.

The resource sectors are described below:

LOWER SAN GORGONIO RIVER — SECTOR A

The dry stream bed of the San Gorgonio River enters the P-C region at the western border near the community of Cabazon and extends for about 8 miles to the east where it joins the Whitewater River (Plates 22 and 23). The San Gorgonio River west of the P-C region lies within the San Bernardino P-C Region and was previously classified as MRZ-2. The Match Corporation and Beaumont Concrete Company extract material from the river floodplain in the San Bernardino P-C Region near Banning. Sector G of the San Bernardino P-C Region covers the available aggregate lands in the San Gorgonio River west of the Palm Springs P-C Region. There is no mining of aggregate in the San Gorgonio River in the Palm Springs P-C Region.

The alluvial deposits of PCC grade quality underlying Sector A are inferred to be at least 100 feet thick, judging from drill holes in the Whitewater River to the east and the two active aggregate mines to the west near Banning. The deposit consists of about 65 percent gravel and 35 percent sand and can be used for PCC-grade aggregate with little or no waste. The coarse material is predominantly metamorphic rocks with minor amounts of granitic rocks. There is no overburden.

All of Sector A lies within the active river channel of the San Gorgonio River and is prone to flooding. The sector is divided by urbanization into three subsectors which contain a total of 641.8 million tons of aggregate resource in an area of 2,449 acres.

Subsector A-1 consists of an area of 172 acres between the Colorado River Aqueduct crossing and the western border of the P-C region (Plate 22). Subsector A-1 contains 47 million tons of aggregate in the upper 100 feet. Subsector A-2 is a 21-acre area between the Colorado River Aqueduct and the Morongo Indian Reservation (Plate 22); it contains 4 million tons of aggregate in the upper 100 feet. Subsector A-3 is the largest part of the sector extending from the east boundary of the Morongo Indian Reservation to Highway 10, which is coincident with the western edge of the Whitewater Canyon fan (Plates 22 and 23). Subsector A-3 covers about 2,256 acres and contains about 594 million tons of aggregate in the upper 100 feet.

WHITewater RIVER — SECTOR B

Sector B is the largest sector in the Palm Springs P-C Region, covering more than 12 square miles (8,013 acres). The sector is subdivided by urbanization into eight subsectors. Subsector B-1 includes that part of the Whitewater River floodplain in the narrow canyon north of Highway 10 (Plate 23). Subsectors B-2 and B-3 cover part of the alluvial fan at the mouth of the canyon and part of the wide floodplain to the east (Plates 23 and 24). Subsector B-4 covers most of the wide wash and floodplain between the fan and the City of Palm Springs (Plates 23 and 24). Subsectors B-5, B-6, B-7, and B-8 cover small areas along the margins of the floodplain isolated by highways and other urban structures (Plates 24 and 25).

Table 3. Aggregate resources in the Palm Springs P-C Region.

Sector	Density (tons/cu. ft.)	Waste (%)	Thickness (feet)	Area (Acres) [Under Permit]	Reserves (million tons)	Resources* (million tons)
A-1	0.63	0	100	172	0	43.7
A-2	0.63	0	100	21	0	4.3
A-3	0.63	0	100	2,256	0	593.8
Subtotals				2,449	0	641.8
B-1	0.63	0	100	756 [30]	**	190.2
B-2	0.63	0	100	971	0	248.1
B-3	0.63	0	100	1,331	0	344.7
B-4	0.63	1	100	4,646 [68]	0	1,227.2
B-5	0.63	1	100	118	0	26.8
B-6	0.63	1	100	81	0	18.4
B-7	0.63	1	100	18	0	3.8
B-8	0.63	1	100	92	0	21.2
Subtotals				8,013 [98]	**	2,080.4
C	0.63	10	30	57	0	4.2
D	0.63	3	35	27 [26]	**	2.1
E-1	0.63	5	25	1,340 [38]	**	86.4
E-2	0.63	5	25	1,358	0	87.5
Subtotals				2,698 [38]	**	173.9
F	0.63	15	25	3,295 [40]	**	190.7
G	0.63	20	60	754 [416]	**	73.2
H-1	0.63	0	15	77 [21]	**	3.1
H-2	0.63	0	30	194 [183]	**	15.1
H-3	0.63	0	35	457	—	43.1
Subtotals				728 [204]	**	61.3
GRAND TOTALS				18,021 [822]	67	3,227.7

*includes reserves

**confidential information

The thickness of the deposit in Sector B is assumed to be at least 100 feet, based on several well logs in all parts of the sector and the depth of mining by the two active aggregate quarries. The Massey Sand and Rock Company extracts aggregate material from an area near the mouth of Whitewater Canyon in subsector B-1, plate 23, and from another area just south of Garnet Hill in subsector B-4, plate 24. The Whitewater plant was active from 1966 to 1968 and restarted in 1985. The Garnet plant has been in continuous operation since 1966. A full range of aggregate products is supplied by these plants. The deposit consists of interbedded gravelly layers and sandy layers from 1 to 3 feet thick. There are boulders up to 3 feet in diameter in the alluvium deposited in Whitewater Canyon. The size of gravel diminishes from the maximum of 3 feet in diameter in the canyon to a maximum of about 4 inches at Garnet, which is about 6 miles from the mouth of the canyon; also the fraction of gravel diminishes from about 65 percent at Whitewater to about 15 percent at the Garnet deposit. The coarse cobbles are composed primarily of granitic rocks in the Whitewater deposit with lesser amounts of metamorphic rocks and volcanic rocks. The composition of the clasts at Garnet is predominantly metamorphic rocks, reflecting the mixing with alluvium from the San Gorgonio River which has a higher percentage of metamorphic rocks.

The entire sector is within the floodplain of the Whitewater and San Gorgonio rivers and is prone to flooding.

There is a total of about 2,080 million tons of aggregate resources in the 8,013 acres of Sector B, all of which is suitable for use in Portland concrete cement. The reserve total for Sector B is confidential.

LITTLE MORONGO CANYON — SECTOR C

The aggregate deposit in Little Morongo Canyon extends from the canyon mouth for a distance of about one mile upstream where it pinches out in the narrow canyon (Plate 24). D.H.S. Ready Mix, Inc. produced concrete sand and gravel from this deposit from the early 1950's until 1972. The property formerly owned by D.H.S. Ready Mix, Inc. is now owned by Suncrete Ready Mix Company, but there has been no production since 1972. The property is not permitted for mining at present.

It is calculated that there are about 4 million tons of aggregate available in this 57-acre sector to a depth of about 30 feet. About 70 percent of this is gravel, consisting of about equal amounts of

metamorphic rocks and granitic rocks. The gravel, which is interstratified with layers of sand, contains boulders up to 2 feet in diameter. It is estimated that the fine fraction or waste is about 10 percent. There has been a small amount of replenishment of aggregate in the abandoned pit during storm runoff periods since 1972.

THOUSAND PALMS AREA — SECTOR D

The alluvial wash of a small unnamed drainage north of the community of Thousand Palms (Plate 26) contains aggregate of PCC quality. The deposit is in a 27-acre area that is from 200 to 400 feet wide and about one mile long. It is estimated by the A-One Aggregates Company that below the mouth of the drainage the deposit is from 25-50 feet with an average depth of 35 feet. In the southern part of the sector, 13 acres are leased by the A-One Aggregates Company, which produces PCC sand and gravel, and 13 acres in the northern part are owned by the E.L. Yeager Construction Company. The A-One Aggregates Company began mining here in 1986; the E.L. Yeager Construction Company has mined intermittently for several years.

It is calculated that there are about 2.1 million tons of aggregate resources in Sector D. The alluvium in this sector is derived primarily from the Quaternary sedimentary units in the Indio Hills. These Quaternary sediments are uplifted and eroded alluvial fans which were derived from the Little San Bernardino Mountains to the north. The gravel clasts are predominantly granitic rocks with minor amounts of metamorphic rocks and sedimentary rocks. The amounts of sand and gravel are about equal and the waste fraction of fine materials is about 3 percent. The reserve figure for Sector D is confidential.

BERDOO CANYON FAN — SECTOR E

Sector E covers the coalescing alluvial fans formed at the mouths of West Berdoo and Berdoo Canyons between the Little San Bernardino Mountains and the Indio Hills (Plate 28). It lies along both sides of Dillon Road for a distance of about 3 miles and is about 5 miles north of Indio. Sector E is divided into two subsectors, E-1 and E-2, by Dillon Road. Subsector E-1 is north and east of Dillon Road and subsector E-2 is west of Dillon Road. There is one active operator in subsector E-1 — Valley Rock and Sand, Inc. — which began mining in 1985. Valley Rock and Sand has all of Section 29 under lease and has a permit to mine on 38 acres in the southwestern corner of that section. A second producer known as PTL (Praise the Lord) was active at some time in the past in subsector E-1; the property, which is near the intersection of Berdoo Canyon Road and Dillon Road, is now idle.

Sector E covers an area of 2,698 acres and is calculated to contain about 174 million tons of PCC-grade aggregate to a depth of 25 feet. The reserve figure is confidential. The thickness of suitable aggregate may be greater, however, but drill-log data is lacking in this area. The deposit is about 50:50 sand to gravel. The gravel in the northern part of the fan, which is derived from West Berdoo Canyon, is composed of predominantly metamorphic rocks. In the remainder of the fan the gravel consists of about equal amounts of granitic and metamorphic rocks. There is no fine-waste fraction in the northern part of the fan, but there may be as much as 10-15 percent fines near the southern margin. An average waste factor of 5 percent was used in

calculating the resources in Sector E. Large boulders on the surface south of the West Berdoo Canyon fan make up less than 1 percent of the deposit.

FARGO CANYON FAN — SECTOR F

Sector F encompasses about 3,295 acres of the large alluvial fan at the mouth of Fargo Canyon (Plates 28, 29 and 31). The fan is on the east side of Dillon Road and about 2 miles north of Indio. The Palm Desert Rock and Sand Company began quarrying aggregate in 1983 on a 40-acre lease in approximately the center of the sector. There is a Bureau of Land Management public borrow area on the southern part of the fan. Although this borrow area is intermittently active, it has not been considered to contain reserves since the material does not enter the market.

The approximately 5 square miles within Sector F are calculated to contain about 191 million tons of PCC-grade aggregate to a depth of 25 feet. The depth of the deposit may be greater but well-log data is lacking in the area. The greatest depth of mining by the Palm Desert Rock and Sand Company was used as the standard for the entire sector. The deposit consists of interbedded sandy and gravelly layers giving an overall average of about 60 percent sand and 40 percent gravel. The fine-waste fraction is about 15 percent. The coarse material is composed predominantly of granitic rocks with lesser amounts of metamorphic rocks. The reserve figure for Sector F is confidential.

INDIO HILLS FAN — SECTOR G

Sector G covers an alluvial fan on the southwestern flank of the Indio Hills, about three miles north of Indio (Plates 27 and 28). About half of the 754-acre sector is under permit and controlled by the Massey Rock and Sand Company which has been mining aggregate here for more than 38 years. This quarry is the largest producer of aggregate material in the Palm Springs P-C Region.

It is calculated that Sector G contains about 73 million tons of PCC-grade aggregate resources to a depth of 60 feet. This is the present depth of mining by the Massey Rock and Sand Company. The reserve figure is confidential. The deposit is composed of about 35 percent gravel, 45 percent sand, and about 20 percent fine-waste material. The clasts are mostly granitic rocks with small amounts of metamorphic rocks. The source area of the material is most likely the Little San Bernardino Mountains to the north; however, the material was probably first deposited in an alluvial fan across what is now the area of the Indio Hills and subsequently uplifted and again eroded. After being deposited in the present alluvial fan near the southern end of the Indio Hills, the deposit has been displaced northwestward, relative to the Indio Hills, by movement on the San Andreas fault.

THERMAL AREA — SECTOR H

Sector H covers an alluvial fan and wash near the mouth of an unnamed canyon about three miles east of the community of Thermal (Plate 31). The sector has been divided into three subsectors (H-1-H-3) to accommodate canals and differences in the deposit. The Valley Rock and Sand Company, Inc. produces PCC-grade aggregate material from the upper part of the allu-

vial fan in subsector H-2 and the lower part of the wash within the canyon in subsector H-1. Aggregate mining has been active here since about 1976.

The approximately 728 acres included in Sector H contain more than 61 million tons of PCC-grade aggregate. The Valley Rock and Sand Company reports that there is no waste in the deposit. However, there is a predominance of sand in the deposit, averaging about 65 percent of the total. The gravel is composed of about 50 percent granitic rocks, and 50 percent metamorphic rocks, with a few sedimentary rocks and occasional mud balls. Subsector H-1, the wash area within the canyon, contains about 3.1 million tons of aggregate spread over 77 acres and receives some replenishment during storm periods. The depth of the deposit in Subsector H-1 is about 15 feet judg-

ing from the excavations by Valley Rock and Sand Company, which has 21 acres under permit. Subsector H-2 — the upper part of the alluvial fan near the mouth of the canyon — contains approximately 15 million tons of aggregate resources spread over 194 acres to a depth of about 30 feet. The depth figure was estimated from well logs in the area and aggregate excavations made during the 1970's. About 183 acres of Subsector H-2 is permitted and is owned or leased by Valley Rock and Sand Company. Subsector H-3 covers about 457 acres on the lower part of the alluvial fan lying southwest of the Coachella Canal. Because of the canal, this part of the fan is no longer active. It is estimated from well logs in the area that the depth of the aggregate deposits here is about 35 feet. There are about 43 million tons of resources in subsector H-3.

CLASSIFICATION OF ACTIVE MINES PRODUCING OTHER MINERAL COMMODITIES

The entire Palm Springs P-C Region has been classified for PCC-grade aggregate. Additionally, during this work, sites of active production of other commodities were encountered. It was decided that deposits which contain active mining operations, even though they are not the source of PCC-grade aggregate, would also be classified MRZ-2 for the specific commodity being produced. However, the resources and reserves at these sites have not been quantified beyond confirmation that the deposit meets or exceeds minimum threshold value established by the Board for that specific commodity. The reader should be aware that this classification of individual mine sites is not to be construed as a classification of the entire region for these commodities — but solely a classification of particular sites where commercial extraction of a mineral resource is occurring.

Three active mines producing other mineral commodities were noted. On the southern side of the Indio Hills, about 2

miles northwest of the community of Thousand Palms, Allen Grading and Paving Company mines No. 3 base and fill from a Pleistocene gravel unit (Ocotillo Conglomerate) (Plate 11). In the southwestern part of the P-C region, about 2 miles southeast of La Quinta, the Riverside County Highway Department excavates alluvial fan material for use as road base and asphaltic aggregate (Plates 16 and 19). About 2 miles north of Whitewater, on the east side of Whitewater River Canyon, the Whitewater Rock and Supply Company quarries decorative stone from the igneous-metamorphic complex (Plates 5 and 6). The product mined here is a sericite-rich, gneissic, granitic rock used as a decorative landscaping and building material. The Bureau of Land Management public borrow pit in Sector F was not considered as an active mine. No other active mineral extraction sites were found within the Palm Springs P-C Region.

ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE

Basis of 50-Year Forecasts

The State Mining and Geology Board, as specified in its "Guidelines for Classification and Designation of Mineral Land" (Part II of California Division of Mines and Geology Special Publication 51), requires that mineral land classification reports for regions containing construction materials classified MRZ-2 include "An estimate of the total quantity of each such construction material that will be needed to supply the requirements of both the county and the marketing region in which it occurs for the next 50 years. The marketing region is defined as the area within which such material is usually mined and marketed. The amount of each construction material mineral resource needed for the next 50 years shall be projected using past consumption rates adjusted for anticipated changes in market conditions and mining technology." In the guidelines, the Board also specifies that these estimates be reviewed periodically (every 10 years or less).

Fifty-year forecasts of PCC-grade-aggregate needs in the Palm Springs P-C Region were made on the basis of reported aggregate-production records during the years 1960-1985. For the purpose of this study, P-C region boundaries were defined to ensure that nearly all (about 99 percent) PCC-grade aggregate produced in the Palm Springs area will be consumed in the study area.

Correlations Between Aggregate Production and Consumption

Past studies of production-consumption regions in California, as reported in Special Report 143, parts II-VII, have shown that there is a strong correlation between the amount of aggregate produced and the population in a given aggregate production-consumption region. On this basis, aggregate production and population figures in the Palm Springs P-C Region were corre-

lated for the years 1960 through 1985 (Table 4 and Figure 9). Correlations between the annual aggregate production records and the population statistics were used to obtain per capita consumption rates of aggregate in the study area. The historical aggregate production data in the study area was obtained from mining records of the U.S. Department of the Interior, Bureau of Mines (1960 to 1985) and the producers. The historical population data for the Palm Springs area were taken from the 1980 census data obtained from Riverside County (1983).

The average per capita consumption rate in the Palm Springs P-C Region is 10.0 tons of aggregate per year over the period from 1961 to 1984 (see Table 4 and Figure 10). Due to the erratic variations in aggregate production from year to year, a three-year moving average of the annual aggregate production was used in conjunction with population statistics (for purposes of curve smoothing) to compute the per capita consumption rates for the P-C region. The moderately high annual consumption rates in the Palm Springs area are characteristic of aggregate marketing regions in which the overall population density is relatively low and the rate of urban development is high. There was a 63 percent population increase in the Palm Springs P-C Region between 1974 and 1984. A moderately high consumption rate probably will be maintained within the Palm Springs P-C Region until the onset of urban maturity, then it will decrease and eventually drop to a general maintenance level. Urban maturity is the point in the development of an area at which construction materials are used primarily to maintain what has already been developed, rather than to provide for further development.

Projected Population and Per Capita Consumption Through The Year 2035

A simple analysis of the historical aggregate production and population statistics was conducted to forecast basic trends in the per capita consumption rate of aggregate within the Palm Springs area through the year 2035. The total aggregate needs of the study area through the year 2035 were calculated on the basis of two factors: (1) a projected average annual per capita consumption rate of 10.0 tons (the average per capita consumption rate for the years 1961 to 1984) and (2) the projected population of the region for future years through the year 2035. Population projections for the years 1986 to 2020 (Figure 11) were obtained from the California Department of Finance (1983). This data was extrapolated by DMG for the study area on a straight line basis through the year 2035 to provide the 50-year population projection as specified under the SMARA guidelines. The results of these calculations (Table 5) reveal that an estimated 156 million tons of aggregate will be needed to satisfy the projected future demand for this construction material in the Palm Springs P-C Region through the year 2035. Of this total, 84.4 million tons must be of PCC-grade (Table 5).

Factors Affecting Per Capita Consumption Rates

The wide variations from year to year in the per capita consumption rate (Table 4) (5.11 to 12.92 tons per person per year) are probably reflections of changes in urban growth rates with

Table 4. Population, aggregate consumption, and per capita consumption in the Palm Springs P-C Region during the period 1960-1985.

YEAR	POPULATION	AGGREGATE CONSUMPTION (rounded to nearest 1,000 tons)	3-YEAR AVERAGE OF CONSUMPTION (tons)	ANNUAL PER CAPITA CONSUMPTION (tons)
1960	53,100	754,000		
1961	57,100	647,000		
1962	59,900	752,000	718,000	12.57
1963	67,100	922,000	774,000	12.92
1964	71,700	688,000	787,000	11.73
1965	77,100	791,000	800,000	11.15
1966	81,600	919,000	799,000	10.57
1967	82,400	1,129,000	946,000	11.59
1968	85,200	551,000	866,000	10.51
1969	86,500	952,000	877,000	10.30
1970	87,000	821,000	775,000	8.95
1971	88,000	496,000	756,000	8.69
1972	96,400	1,747,000	1,021,000	11.48
1973	105,800	919,000	1,054,000	10.94
1974	106,200	792,000	1,153,000	10.89
1975	107,900	520,000	744,000	7.01
1976	107,400	341,000	551,000	5.11
1977	110,300	1,158,000	673,000	6.27
1978	122,200	1,237,000	912,000	8.27
1979	128,400	1,226,000	1,207,000	9.88
1980	133,000	1,644,000	1,369,000	10.66
1981	142,400	1,404,000	1,425,000	10.71
1982	151,700	1,348,000	1,465,000	10.29
1983	161,000	1,390,000	1,381,000	9.10
1984	170,400	1,741,000	1,493,000	9.27
1985	179,000	2,415,000	1,849,000	10.85

Average annual per capita consumption for 1961-1984 is 10.0 tons per person per year.

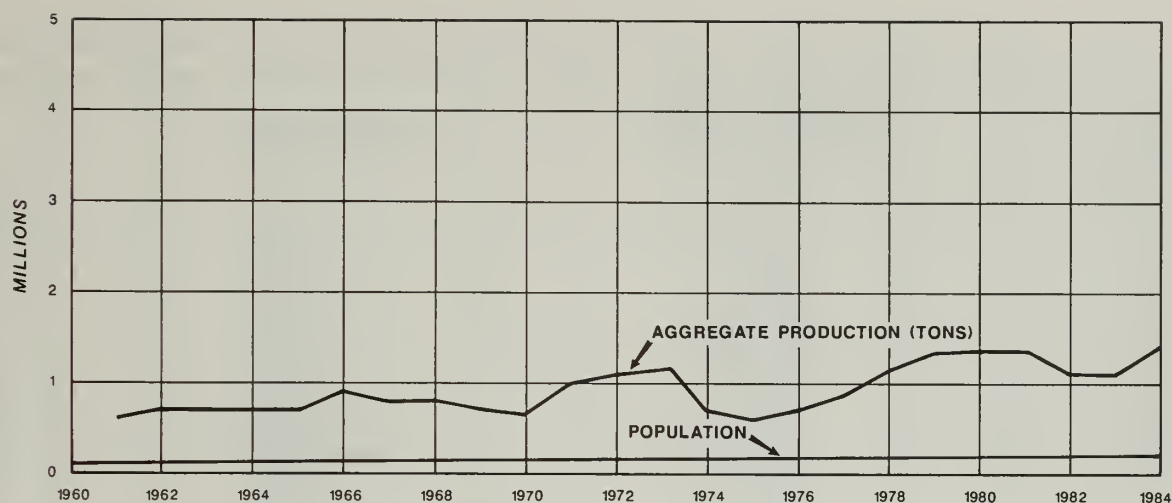


Figure 9. Palm Springs P-C Region: Population and aggregate production records for years 1960-1984. Annual aggregate production has been smoothed through use of a 3-year moving average.

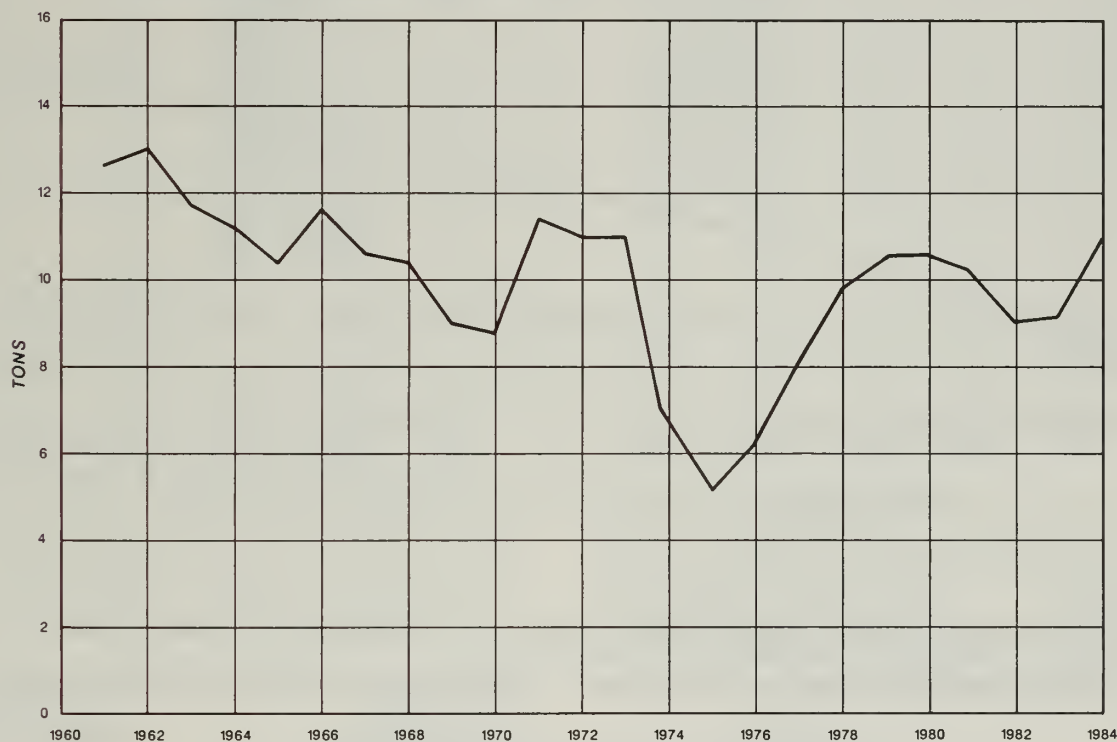


Figure 10. Annual per capita consumption of aggregate in the Palm Springs P-C Region.

time, and the construction of major facilities (for example, freeways). In part, these variations result from incompletenesses and inaccuracies in the production records supplied to the U.S. Bureau of Mines. Certainly the economic climate is a powerful variable that influences the annual per capita consumption rates for aggregate. Very high interest rates, for example, tend to lower the amount of new construction in an area and consequently lower the demand for aggregate.

At some point in the future, the average annual per capita consumption rate of 10.0 tons for the Palm Springs P-C Region will probably decrease with the onset of urban maturity and then stabilize at a lower rate. However, should unforeseen events occur, such as massive urban renewal, disaster reconstruction, or a

major recession, the per capita consumption rate could change radically.

Comparison of the 50-Year Aggregate Demand With Current Reserves

The total PCC-grade aggregate reserves for the Palm Springs P-C Region were estimated to be 67 million tons. (This figure does not reflect reserve depletion by any producer since December, 1985). At the average rate of past aggregate consumption in the region (10.0 tons per person annually), these reserves are theoretically sufficient to satisfy total aggregate demands of the P-C region to 2012.

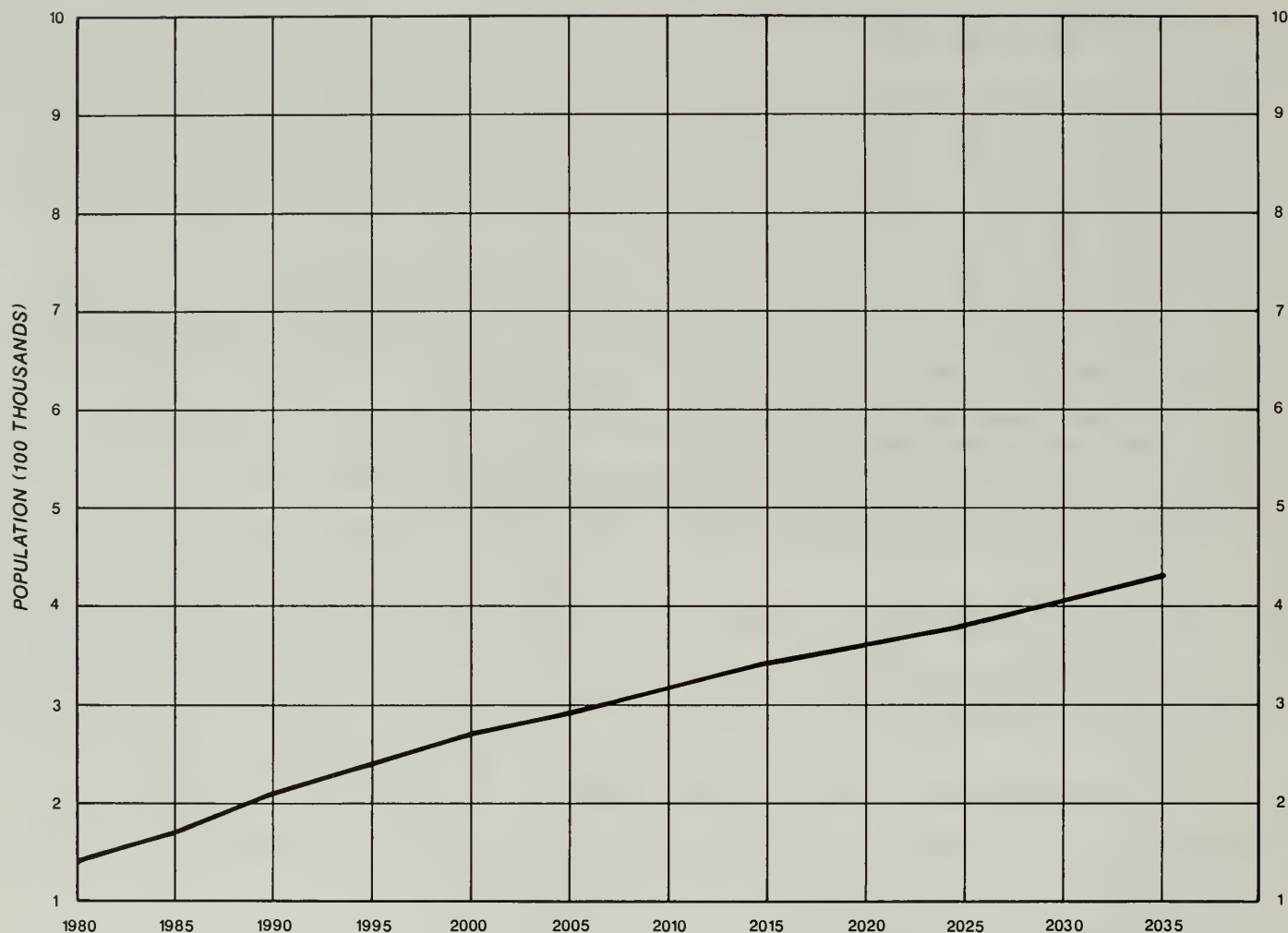


Figure 11. Projected population (50 years from date of study) of the Palm Springs P-C Region.

TABLE 5. Projected aggregate consumption through the year 2035 for the Palm Springs P-C Region. Five-year per capita consumption = 50 tons/person (one-year per capita consumption = 10 tons/person).

YEARS	*AVERAGE POPULATION (Millions)	AGGREGATE CONSUMPTION ALL AGGREGATE (million tons)	**AGGREGATE CONSUMPTION PCC AGGREGATE (million tons)
1986-1990	.189	9.5	5.1
1991-1995	.221	11.1	6.0
1996-2000	.254	12.7	6.9
2001-2005	.281	14.1	7.6
2006-2010	.304	15.2	8.2
2011-2015	.327	16.4	8.9
2016-2020	.350	17.5	9.5
2021-2025	.373	18.7	10.1
2026-2030	.396	19.8	10.7
2031-2035	.421	21.1	11.4
TOTALS		156.1	84.4

*Population projections for the years 1986-2020 were obtained from the California Department of Finance Report 83-P-3. Population projections for the years 2020-2035 were linearly projected from data in the previous years.

**This estimate is based on the fact that approximately 54 percent of the aggregate consumed in Riverside County from 1973 to 1982 was for PCC (Table 6).

Table 6. Portland cement concrete aggregate production record of Riverside County for the years 1960-1985.*

YEAR	TOTAL AGGREGATE PRODUCTION (tons)	PORTLAND CEMENT CONCRETE AGGREGATE (PCC) PRODUCTION (tons)	% PCC AGGREGATE OF TOTAL
1960	1,449,170	353,313	24.4
1961	1,484,587	287,216	19.3
1962	1,618,510	396,243	24.5
1963	2,282,871	581,293	25.5
1964	2,059,000	703,000	34.1
1965	3,112,000	938,000	30.1
1966	4,866,000	868,000	17.8
1967	5,019,000	577,000	11.5
1968	2,563,000	678,000	26.5
1969	3,699,000	545,000	14.7
1970	3,695,000	1,035,000	28.0
1971	3,749,000	1,265,000	33.7
1972	5,039,000	1,642,159	32.6
1973	2,848,457	1,375,888	48.3**
1974	3,464,619	2,102,675	60.7**
1975	2,592,200	1,720,722	66.4**
1976	4,399,632	3,170,153	72.1**
1977	7,701,141	4,249,149	55.2**
1978	7,695,637	4,095,077	53.2**
1979	8,409,448	4,694,100	55.8**
1980	8,273,276	3,606,784	43.6**
1981	NOT AVAILABLE		?
1982	5,836,865	2,508,602	43.0**
1983	NOT AVAILABLE		?
1984	NOT AVAILABLE		?
1985	NOT AVAILABLE		?

* As reported by the Bureau of Mines

** Years used in calculation of average annual percent of PCC production of 53.7 percent (the marked increase in percentage of PCC production since 1973 is expected to continue in the foreseeable future).

According to U.S. Bureau of Mines aggregate production statistics for Riverside County for the years 1973 to 1982 and information from aggregate operators in the P-C region, it is estimated that roughly 54 percent of the total aggregate consumed in the study region has been PCC-grade (Table 6). If the region continues to require the same percentage of PCC-grade aggregate, the total amount of PCC-grade aggregate that would be needed to supply the Palm Springs area through the year 2035 is estimated to be 84.4 million tons (Table 5). If the 67-million-ton reserve of PCC-grade aggregate was used exclusively for PCC, the supply would not be sufficient for the next 50 years

(Table 7). However, such exclusive use of all of the PCC-grade aggregate reserves in the region is unlikely.

Table 7. Summary of aggregate resources and 50-year demand for the Palm Springs P-C Region.

• Resources (includes reserves)	3,227,700,000 tons
• Reserves (permitted resources)	67,000,000 tons
• 50-year demand, total aggregate	156,100,000 tons
• 50-year demand, PCC aggregate	84,400,000 tons

ALTERNATIVE SOURCES OF AGGREGATE

Potential sources of Portland cement concrete aggregate, in addition to the deposits classified MRZ-2, exist within the Palm Springs P-C Region. These potential sources lie within areas that are classified MRZ-3 and include areas underlain by Quaternary alluvial deposits, Tertiary sedimentary deposits, and granitic and metamorphic basement rocks. Too little is known about these alternative sources to allow more than a general description.

Potential Alluvial Aggregate Sources

Alluvium classified MRZ-3 includes Quaternary fans, floodplains, and washes formed by the erosion of the San Bernardino

Mountains, Little San Bernardino Mountains, Indio Hills, Mecca Hills, and the San Jacinto Mountains. The source rocks and the energy of the depositional environment varies from one drainage basin to another resulting in differences in the hardness and composition of the clasts and the grain sizes and sorting of the alluvial deposits. Thus, although sand and gravel exist within these areas classified MRZ-3, the suitability of the material as concrete aggregate is questionable and variable.

Aggregate material in the Mission Creek Wash and Fan Hill Canyon alluvial fan was used in the construction of the Colorado River Aqueduct. Data on the specific use and quality of that material was not available. None of the remaining deposits are known to have been used for PCC aggregate.

There is a tremendous volume of aggregate material in the fans and washes of the region and much of it may prove to be suitable for PCC-grade. Deposits that appear from field observation to be the most promising are those in the Mission Creek and Dry Morongo Creek Wash areas, the alluvial fans between the Indio Hills and the Little San Bernardino Mountains, and the Thermal Canyon Wash area.

There are several older alluvial formations that have been deformed and uplifted along the San Andreas fault and other faults within the area. Some of these formations are exposed in the Mecca Hills, the Indio Hills, and foothills of the San Bernardino Mountains northwest of Palm Springs, such as the Cabezon Fonglomerate, Ocotillo Conglomerate, and the Palm Springs Formation. Some of the recent alluvial deposits that are being actively mined for aggregate have formed from the erosion and redeposition of these older alluvial formations. It is likely that some parts of these units may be suitable for PCC-grade sand and gravel.

Potential Crushed Rock Sources

Because of the abundant alluvial resources in the Palm Springs P-C Region, it is unlikely that crushed rock will be quarried in the near future for use as PCC aggregate. However, should the need ever arise, there are large areas underlain by potential crushed rock sources in and near the region. The basement rocks exposed in the Little San Bernardino Mountains and

the San Jacinto Mountains consist of granitic intrusive rocks, such as granodiorite and tonalite, and metamorphic rocks such as gneiss and schist. Site specific evaluation and testing would be necessary to determine the suitability of these basement rocks for use as PCC-grade aggregate.

Potential Sources of PCC-Grade Aggregate Outside of the P-C Region

PCC-grade aggregate is being obtained for use in the Palm Springs P-C Region from the San Gorgonio River area near Banning in the neighboring San Bernardino P-C Region. Since the report on the San Bernardino P-C Region (Miller, 1983) was completed, the importation of aggregate from the two producers in the San Gorgonio River has increased greatly. It would violate the confidentiality of the production data for the two producers to reveal the percentage of aggregate being imported; however, the percentage imported in 1986 exceeded 10 percent of the total consumption of the Palm Springs P-C Region.

Other sources of PCC aggregate in adjacent areas are in the Brawley area to the south, the Twenty-Nine Palms area to the north, and the Redlands area to the west. The additional transport costs (see Table 8) incurred by bringing in aggregate from these other sites substantially increases the price of construction materials to consumers in the Palm Springs area. Utilization of these deposits by the Palm Springs market area could cause supply problems in the areas they now serve.

Table 8. Transport distance and additional cost of aggregate trucked from active deposits nearest the Palm Springs P-C Region. Transportation rates taken from California Public Utilities Commission minimum rate tariff 7-A, 1987.

AREA	*DISTANCE FROM DOWNTOWN PALM SPRINGS	INCREASE IN HAUL DISTANCE OVER LOCAL DEPOSITS	ADDITIONAL COST PER TON FOR TRANSPORT(\$)
Banning	25	20	3.00
Redlands	50	40	5.15
Twenty-Nine Palms	55	45	5.67
Brawley	95	90	10.10

* Rounded to nearest five miles; measured along major roads.

CONCLUSION

Within the Palm Springs P-C Region, eight sectors (A-H) have been identified that contain over 3.2 billion tons of aggregate resources.

Based on available production data and population projections, the Palm Springs P-C Region will need 156.1 million tons of aggregate during the next 50 years. Of this projected demand, approximately 54 percent (84.4 million tons) must be suitable for

Portland cement concrete. The approximately 67 million tons of aggregate reserves calculated to exist within the P-C Region amount to 43 percent of the projected demand for all aggregate over the next 50 years. Unless new resources are permitted for mining, or alternative resources are utilized, existing reserves will be depleted during the year 2011. If a major earthquake was to strike the P-C region and necessitate reconstruction, the depletion of existing reserves would be faster.

ACKNOWLEDGMENTS

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Massey Sand and Rock Company, E.L. Yeager and Susan Prosenik of E.L. Yeager Construction Company, Steve Holliday of Valley Rock and Sand Company, Mike Schreck of A-One Aggregates Company, Donald Fincher and Lillian Englert of A.V. Ready Mix, the Palm Desert Rock and Sand Company, and Lewis Bishop of Suncrete Ready Mix Company.

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APPENDIX

Interim Criteria for Sectorization of MRZ-2 Areas for Aggregate

The purpose of sectorizing MRZ-2 areas is to provide a semi-quantified estimate of construction aggregate resources which are likely to be available to satisfy society's needs during the next 50 years. This estimate, when compared to DMG projected needs for the next half century, provides the context for communities to plan for future resource availability in their land-use policies. The determination of sectors is intended for the use of the State Mining and Geology Board (MGB) in identifying areas which are candidates for designation under SMARA. This information is distributed by the Board to all affected lead agencies to provide them with the data necessary to plan for future resource availability in their land-use policies.

Areas within MRZ-2 classifications are sectorized if they have current land uses which are similar to those in areas which have undergone mineral extraction in the past. Areas within MRZ-2 classifications which have generally not been available for surface mining in the past for specified social or economic reasons are not sectorized. Since such areas are unlikely to be used for surface mining during the foreseeable future, their inclusion in estimates of future resource availability would be misleading.

The estimation of future mineral resource availability in sectors is not a precise analysis, but rather is the best general estimate which can be made with the data presently available. Areas within and without sectors can be used for mining or other land uses at the discretion of the local governments which are charged with responsibility for making land-use decisions. Establishment of sectors in no way infringes on this authority. Rather, it provides a perception of future mineral resource availabilities in the face of future needs and also portrays where these available minerals are generally located.

The following criteria was used by DMG in identifying mineral resource areas which are available for future use. These criteria, in conjunction with the geologic and geometric characteristics of specific mineral deposits was used in sectorizing

MRZ-2 areas. Use of these criteria assures that sectors contain geologically homogeneous mineral deposits which, based upon current land use, will be available for future use.

The following specific land uses are considered to be generally incompatible with mining and have been excluded from sectorized lands. Mineral resource areas containing land uses not specifically listed will be considered for sectorization. The criteria are to be applied only to lands classified as MRZ-2.

There are two general categories of exclusion: 1) Economic Exclusion, and 2) Social Exclusion.

(I) *Economic Exclusion*

Specific excluded land uses are:

- 1) Residential areas,
- 2) Commercial areas with land improvements (buildings),
- 3) Industrial areas (buildings and adjacent needed storage and parking facilities), and
- 4) Major public or private engineering projects, including:
 - a) canals
 - b) freeways
 - c) bridges
 - d) airports and associated developments such as parking lots
 - e) dams
 - f) railroads
 - g) major pipelines
 - h) major power transmission lines

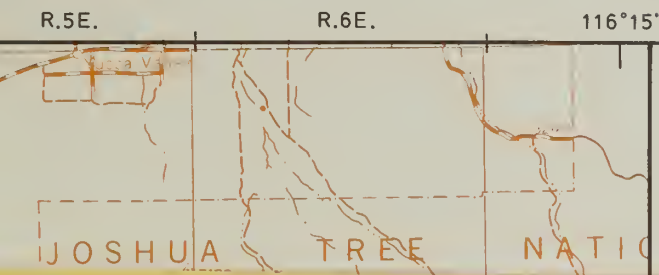
(II) *Social Exclusion*

Specific excluded land uses are:

- 1) Cemeteries,
- 2) Geologic Scientific Zones,
- 3) Public parks, developed historical sites and structures, and public recreation areas of all types,
- 4) Public or private schools, institutions, hospitals, and prisons, including adjacent grounds and related structures, and
- 5) Military bases and reservations.

**MINERAL LAND CLASSIFICATION:
AGGREGATE MATERIALS IN THE PALM SPRINGS P-C REGION**

Special Report 159



ACTIVE AGGREGATE QUARRIES IN THE PALM SPRINGS P-C REGION

- 1 Massey Rock and Sand Co.--Whitewater
- 2 Massey Rock and Sand Co.--Garnet

1988



COLLATE:

31 PIECES

CALIFORNIA DEPARTMENT OF CONSERVATION DIVISION OF MINES AND GEOLOGY

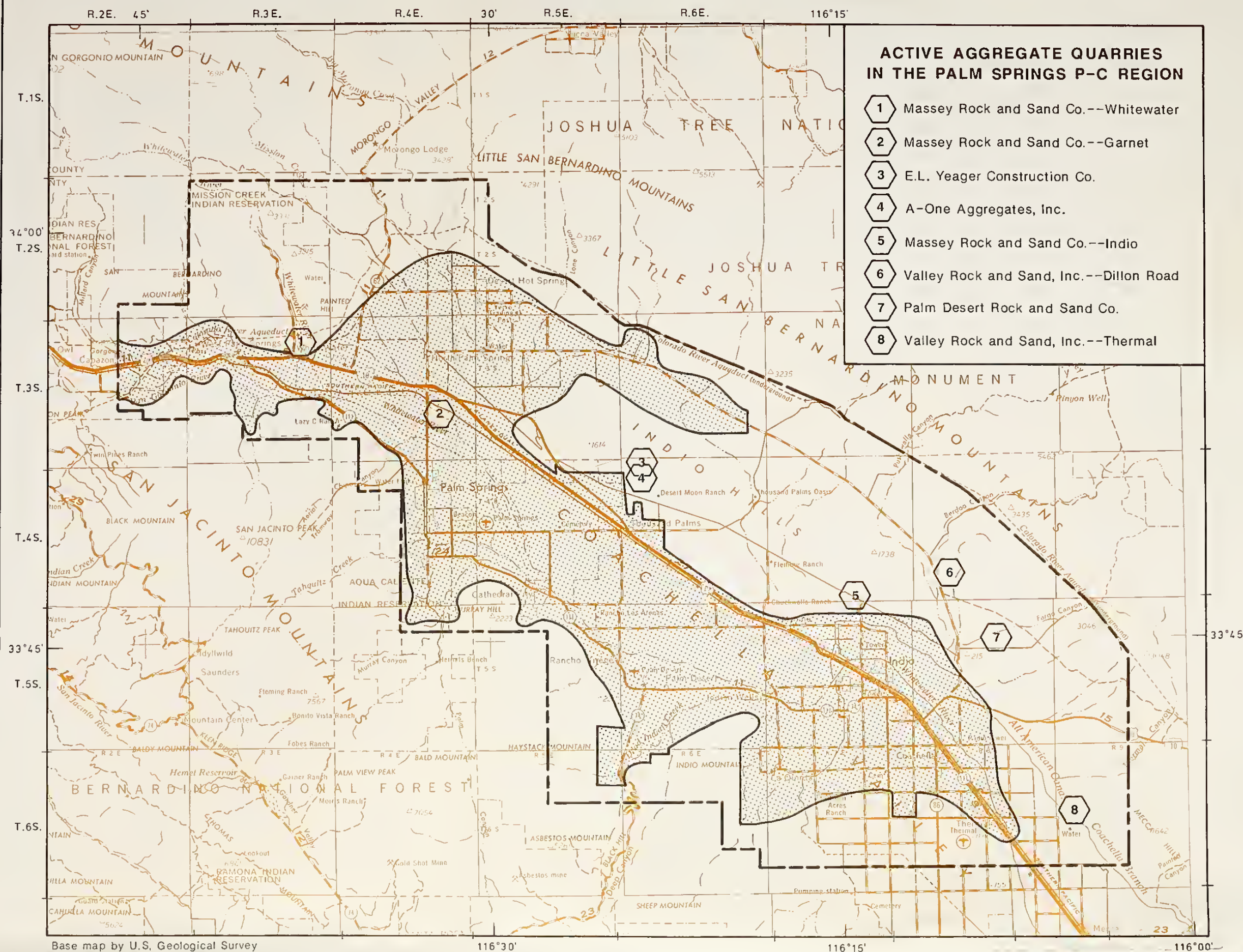
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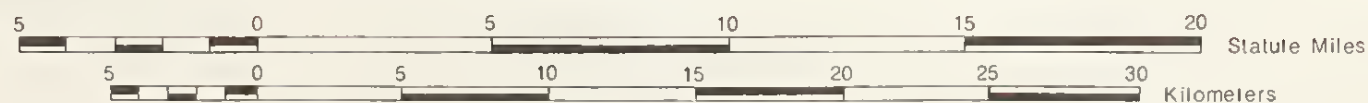
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RANDALL M. WARD
DIRECTOR



SCALE 1:250,000



EXPLANATION

--- Production-Consumption Region Boundary. Includes resource areas and the area they serve.



Areas identified by the Office of Planning and Research (OPR) which are either urbanized or projected to urbanize (urbanizing areas) by the year 1990.

PALM SPRINGS P-C REGION
RIVERSIDE COUNTY, CALIFORNIA

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CATCLAW FLAT QUADRANGLE

SPECIAL REPORT 159 PLATE 2

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONCLUSIONS
NOTES

CATCLAW FLAT, CALIF.

EXPLANATION

DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
information supplied by local government and other sources.

MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete Grade Aggregate unless otherwise indicated by Commodity name enclosed in parentheses

MRZ-1	Areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence.
MRZ-2	Areas where adequate information indicates that significant mineral deposits are present, or where it is judged that a high likelihood for their presence exists.
MRZ-3	Areas containing mineral deposits the significance of which cannot be evaluated from available data.
MRZ-4	Areas where available information is inadequate for assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

ACTING STATE GEOLOGIST JUNE 19, 1987

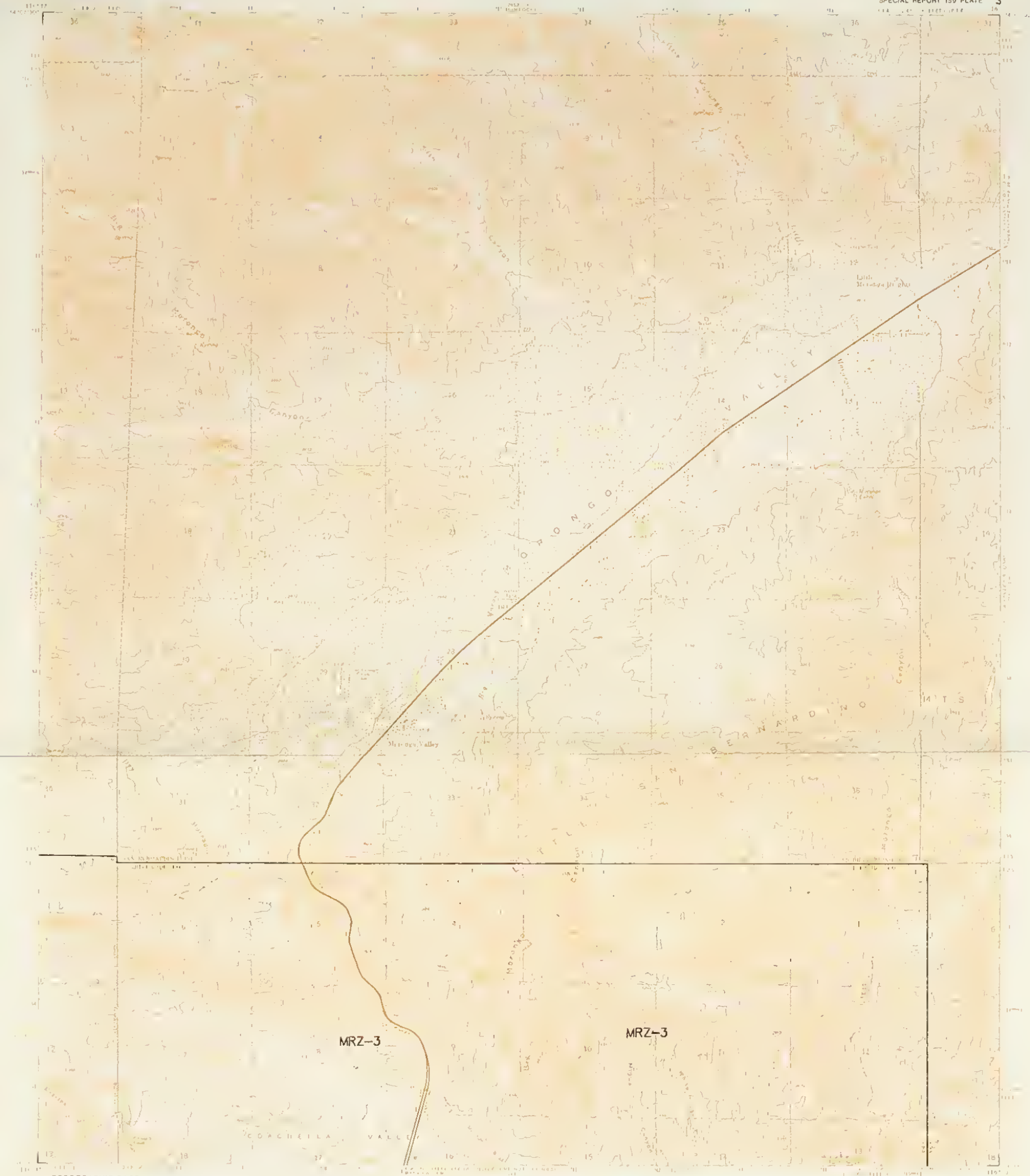


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BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

MORONGO VALLEY QUADRANGLE

SPECIAL REPORT 159 PLATE 3



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

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NOR THE U.S. GOVERNMENT IS RESPONSIBLE

EXPLANATION



DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
information supplied by local government and other sources

MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
Commodity name enclosed in parentheses

MRZ-2

- MRZ-1 Areas where adequate information indicates that no
significant mineral deposits are present, or where it is
judged that little likelihood exists for their presence
- MRZ-2 Areas where adequate information indicates that
significant mineral deposits are present, or where it is
judged that a high likelihood for their presence exists
- MRZ-3 Areas containing mineral deposits the significance of
which cannot be evaluated from available data
- MRZ-4 Areas where available information is inadequate for
assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols

N

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker

ACTING STATE GEOLOGIST JUNE 19, 1987

MORONGO VALLEY, CALIF

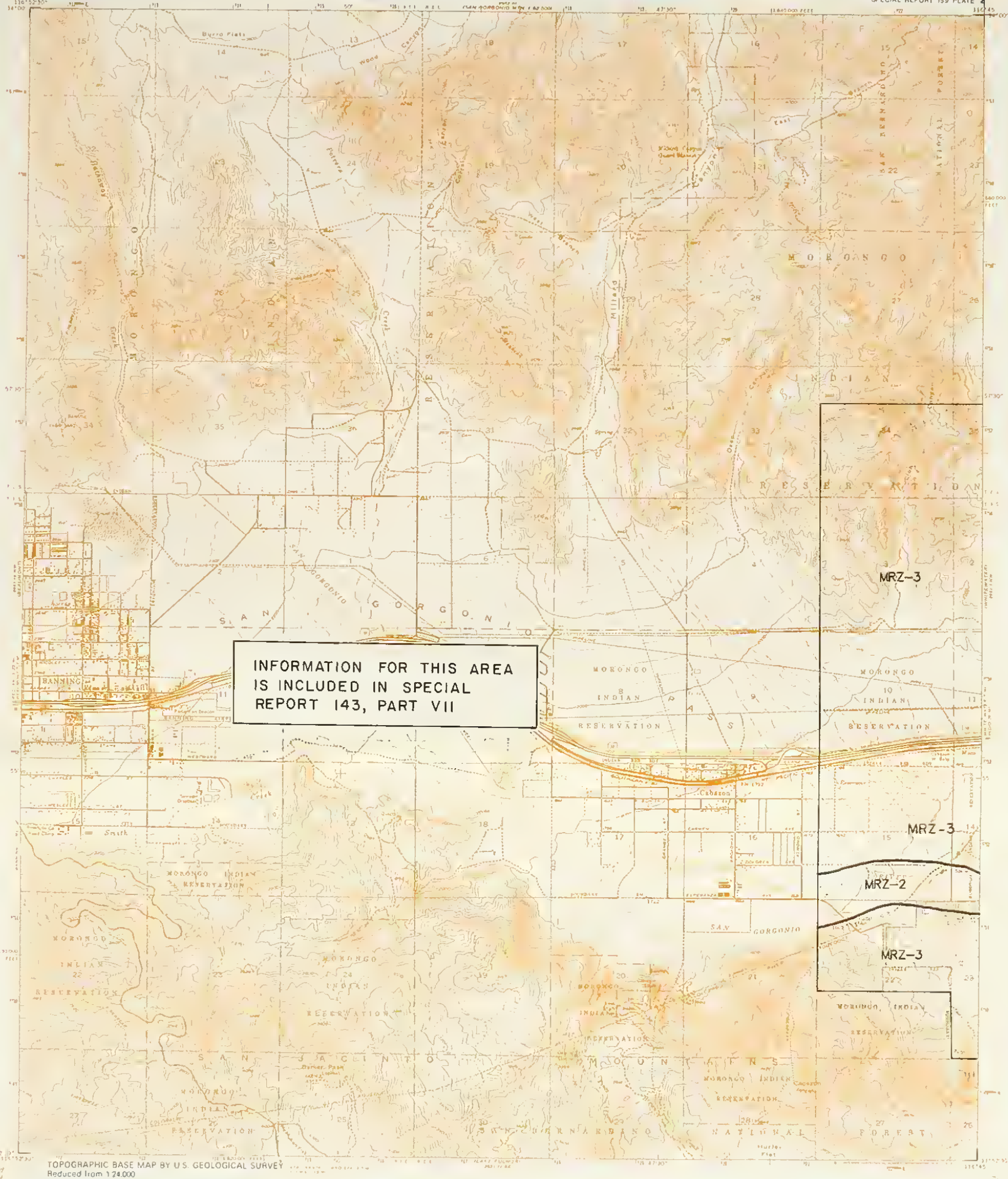


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CABAZON QUADRANGLE

SPECIAL REPORT 159 PLATE 4



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000



EXPLANATION

● ORILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
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MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
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- MRZ-3 Areas containing mineral deposits the significance of
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assignment to any other MRZ zone

See 10-1 for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

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RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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ACTING STATE GEOLOGIST JUNE 19, 1987

CABAZON, CALIF

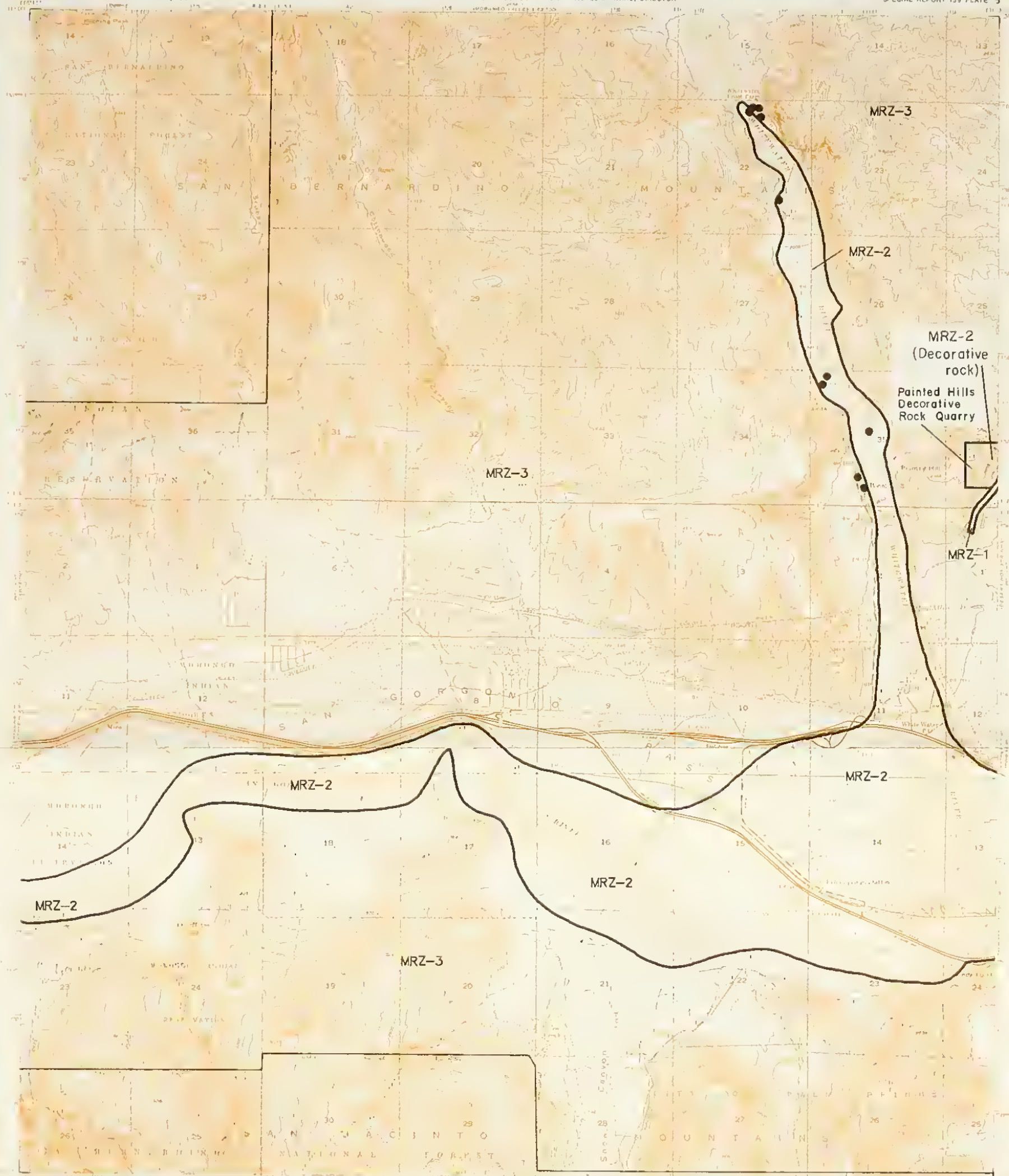


WHITEWATER QUADRANGLE

SPECIAL REPORT 159 PLATE 5

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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
ELEVATION IN FEET
GRID 1:24,000 (1:24,000)

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
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MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
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which cannot be evaluated from available data
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assignment to any other MRZ zone

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

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Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

WHITEWATER, CALIF



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DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

DESERT HOT SPRINGS QUADRANGLE

SPECIAL REPORT 159 PLATE 6



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
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ACTING STATE GEOLOGIST JUNE 19, 1987



SEVEN PALMS VALLEY QUADRANGLE

SPECIAL REPORT 159 PLATE 7

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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

VERTICAL INTERVAL IN FEET

SEVEN PALMS VALLEY, CALIF.

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
information supplied by local government and other sources

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which cannot be evaluated from available data
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assignment to any other MRZ zone

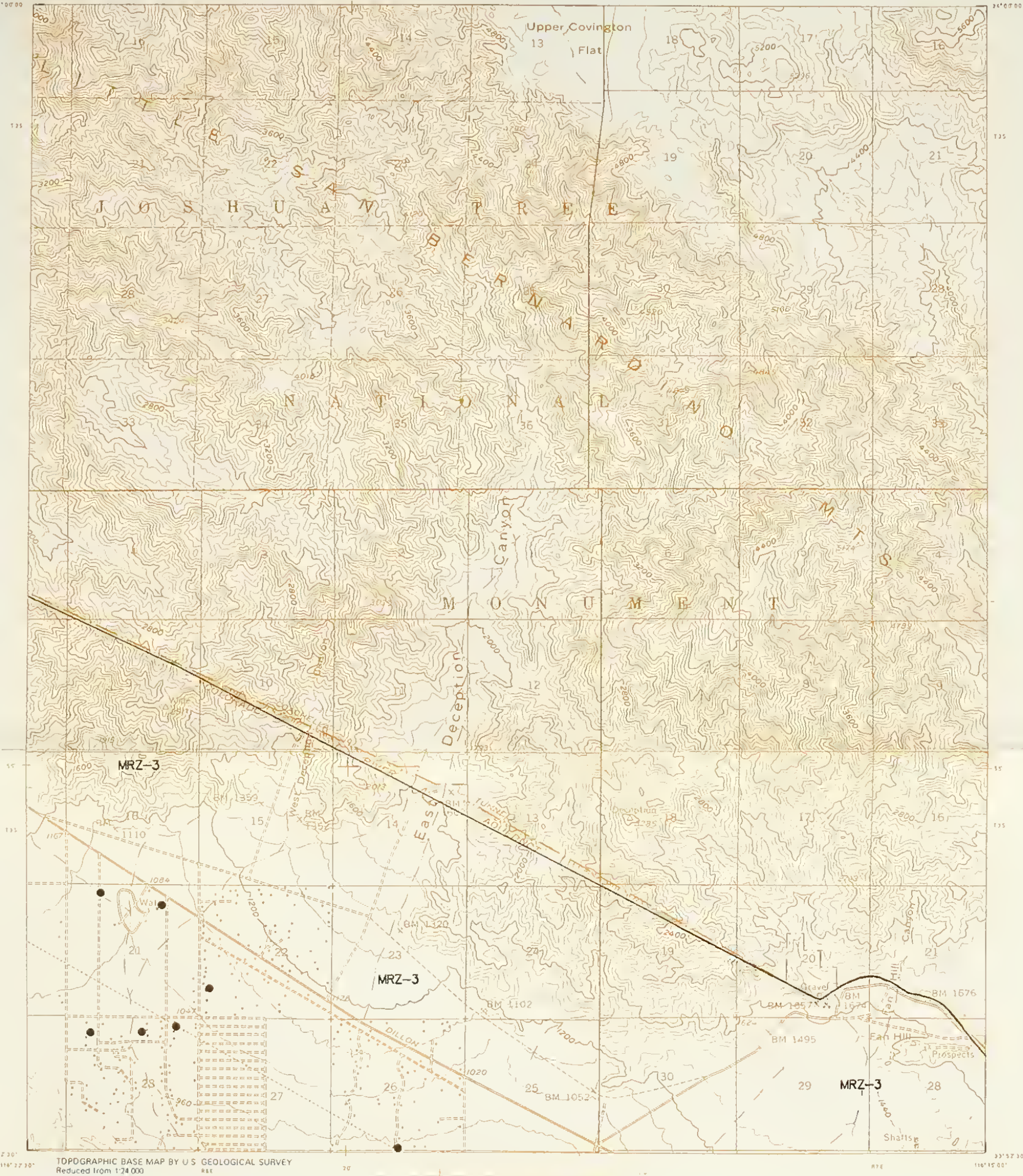
See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

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ACTING STATE GEOLOGIST JUNE 19, 1987



EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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information supplied by local government and other sources

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All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
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assignment to any other MRZ zone

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

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THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

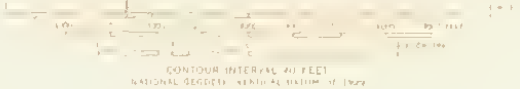
LOST HORSE MTN NW1/4 QUADRANGLE

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

SPECIAL REPORT 159 PLATE 9



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000



EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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information supplied by local government and other sources.

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Grade Aggregate unless otherwise indicated by
Commodity name enclosed in parentheses.

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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY
Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker

ACTING STATE GEOLOGIST JUNE 19, 1987

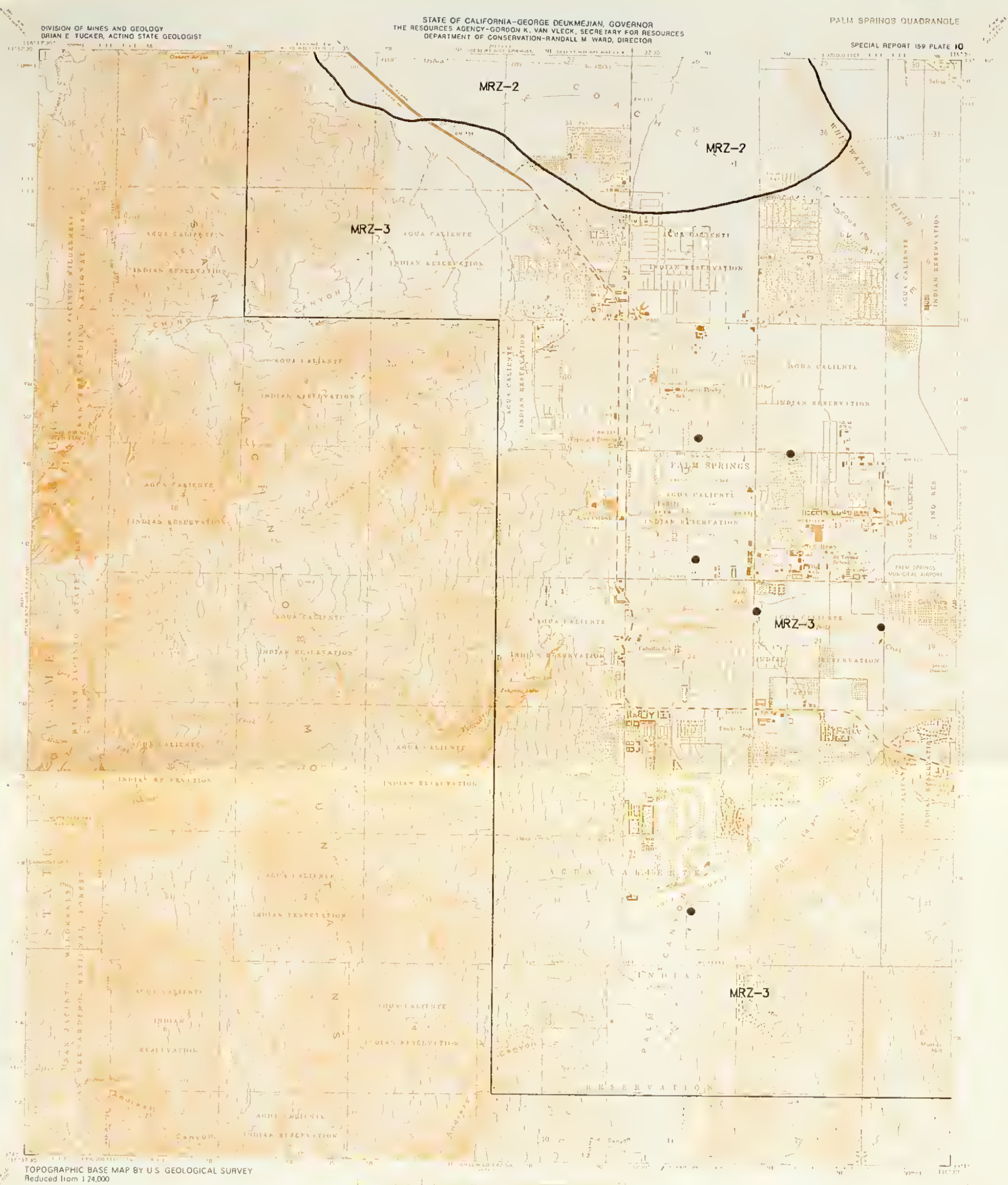


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PALM SPRINGS QUADRANGLE

SPECIAL REPORT 159 PLATE 10



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
information supplied by local government and other sources

MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
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assignment to any other MRZ zone.

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

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RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PALM SPRINGS, CALIF

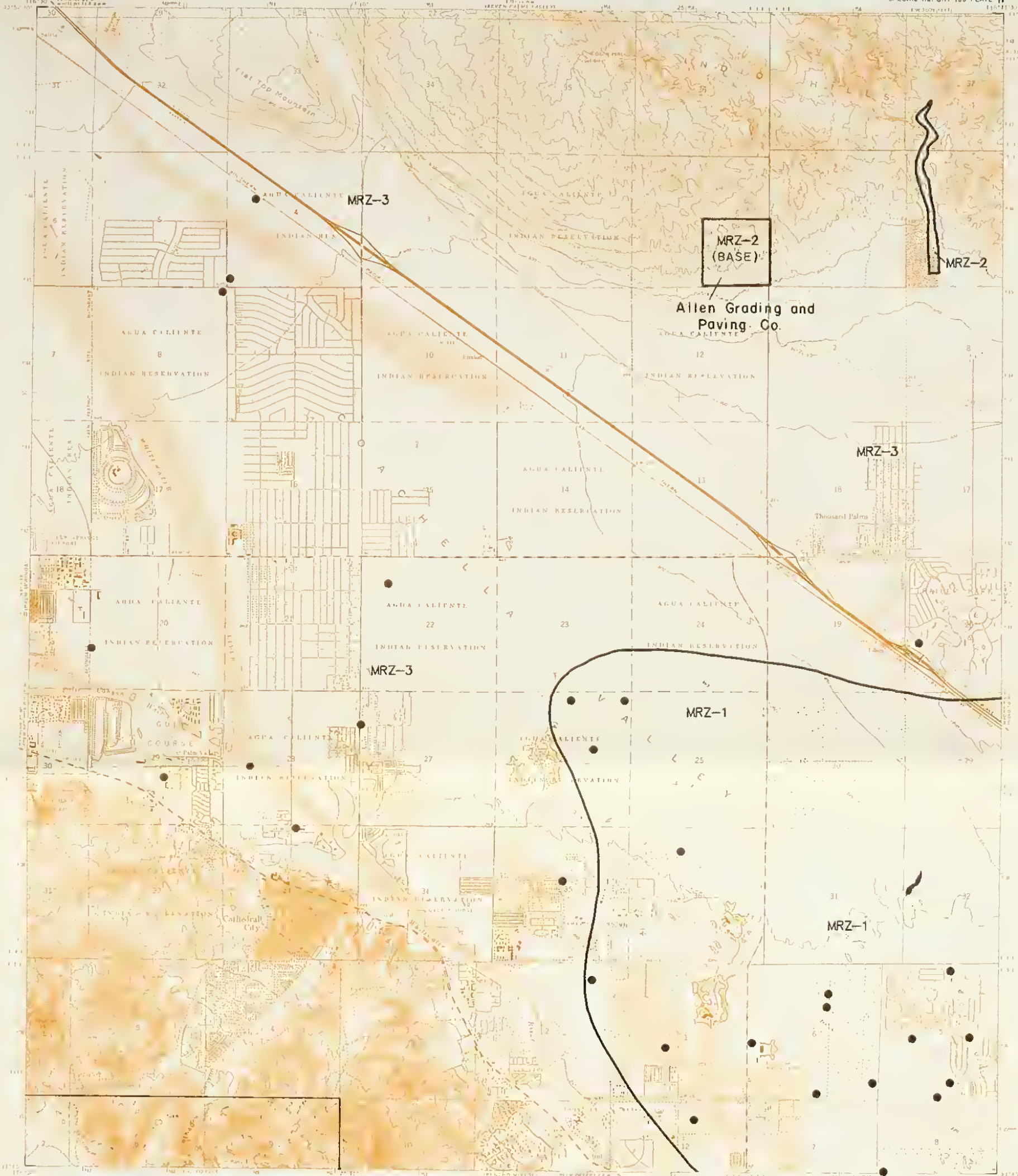


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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

CATHEDRAL CITY QUADRANGLE

SPECIAL REPORT 158 PLATE II



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
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MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
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assignment to any other MRZ zone

See text for additional explanation of MRZ Symbols



MINERAL LAND CLASSIFICATION MAP
AGGREGATE RESOURCES ONLY
Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker

ACTING STATE GEOLOGIST JUNE 19, 1987

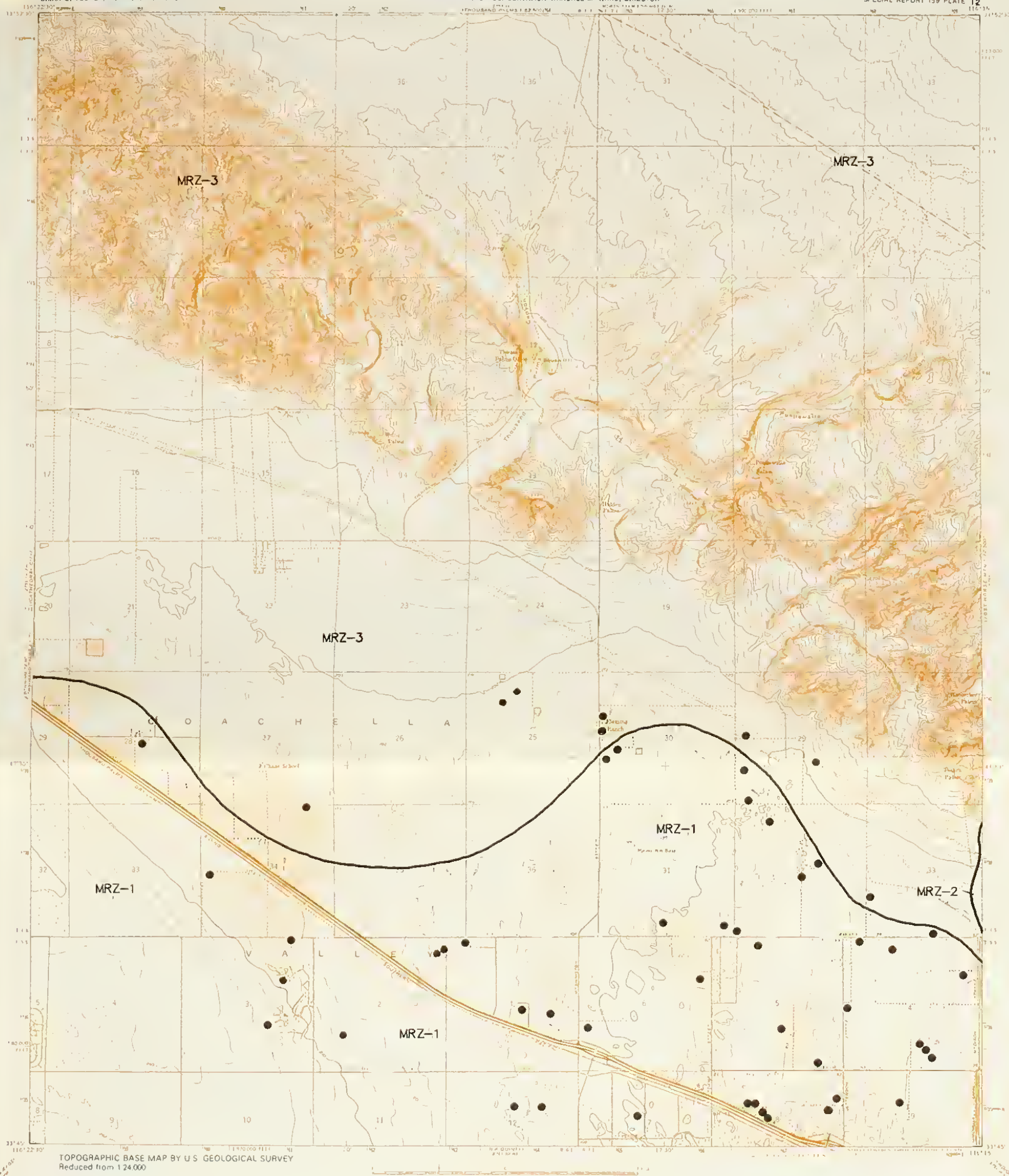


MYOMA QUADRANGLE

SPECIAL REPORT 159 PLATE 12

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BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR



EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
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MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

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RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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ACTING STATE GEOLOGIST JUNE 19, 1987



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THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

LOST HORSE MTN SW 1/4 QUADRANGLE

SPECIAL REPORT 150 PLATE 13



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
NATIONAL GEODESIC DATUM OF 1929

LOST HORSE MTN SW 1/4, CALIFORNIA

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

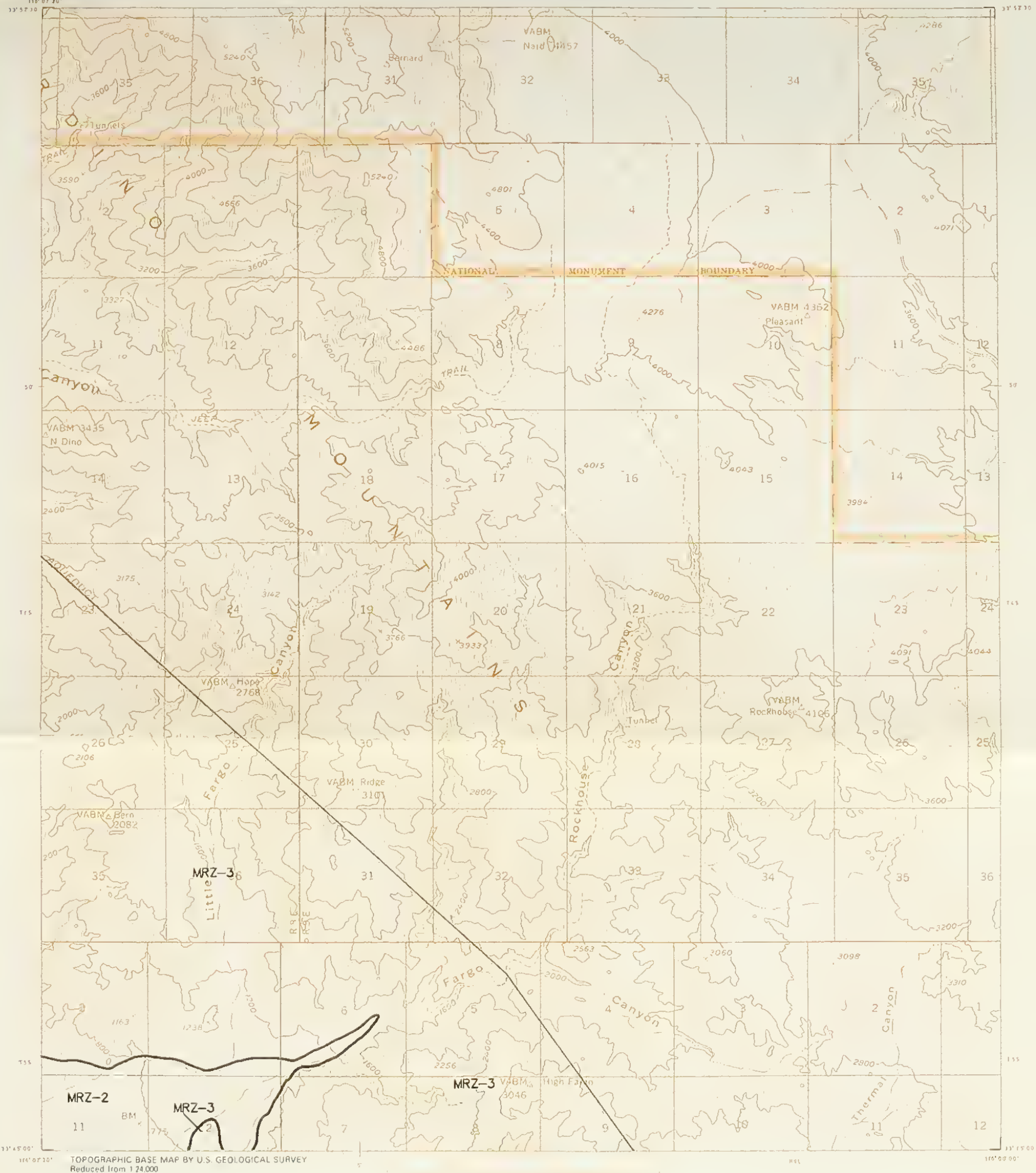


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LOST HORSE MTN SE1/4 QUADRANGLE

SPECIAL REPORT 159 PLATE 14



EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

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ACTING STATE GEOLOGIST JUNE 19, 1987



RANCHO MIRAGE QUADRANGLE

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

SPECIAL REPORT 159 PLATE 15



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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MINERAL RESOURCE ZONE BOUNDARIES

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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
Russell V. Miller
1987

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RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker

ACTING STATE GEOLOGIST JUNE 19, 1987

RANCHO MIRAGE, CALIF

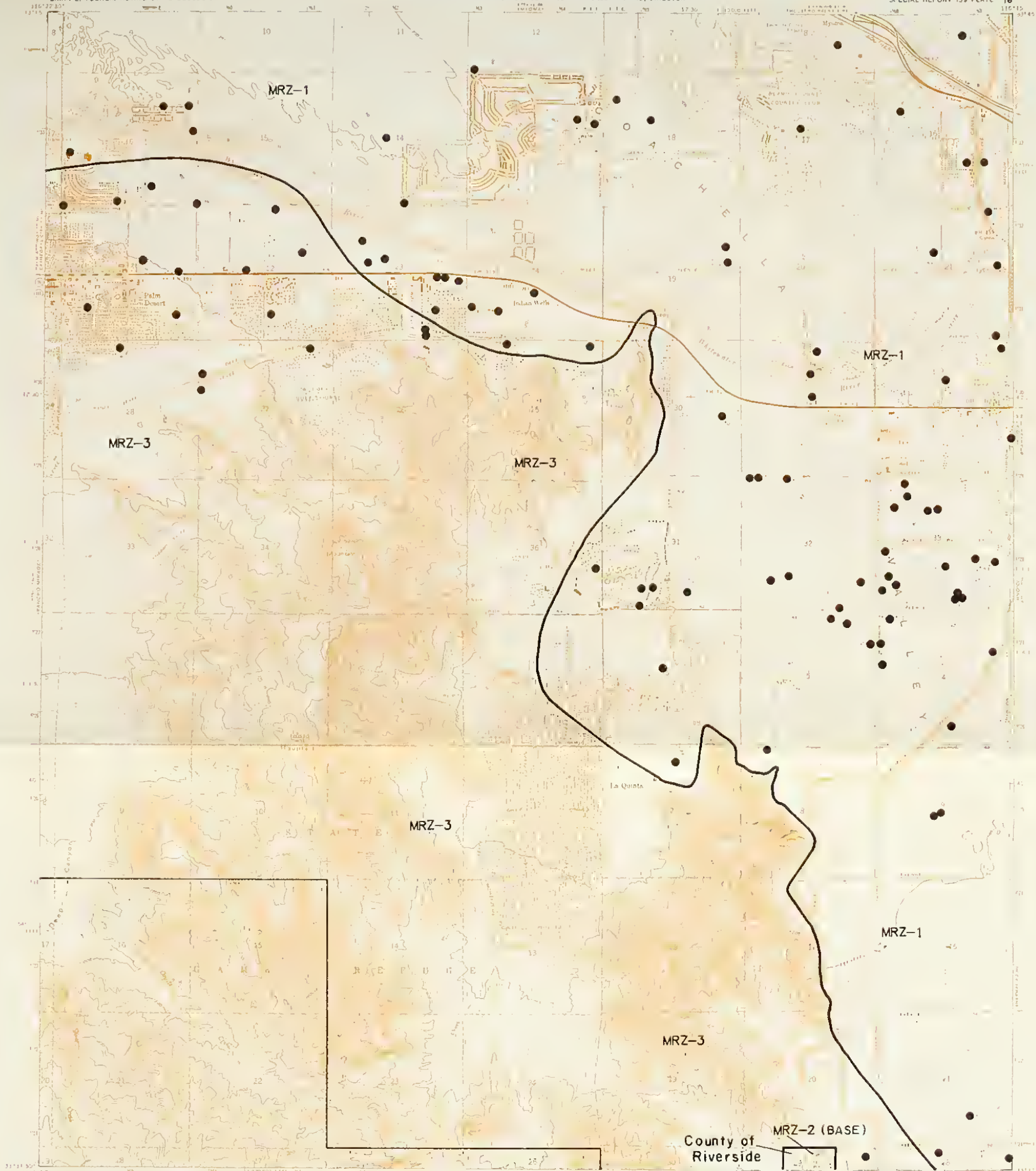


LA QUINTA QUADRANGLE

SPECIAL REPORT 159 PLATE 16

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
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which cannot be evaluated from available data
- MRZ-4 Areas where available information is inadequate for
assignment to any other MRZ zone

See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

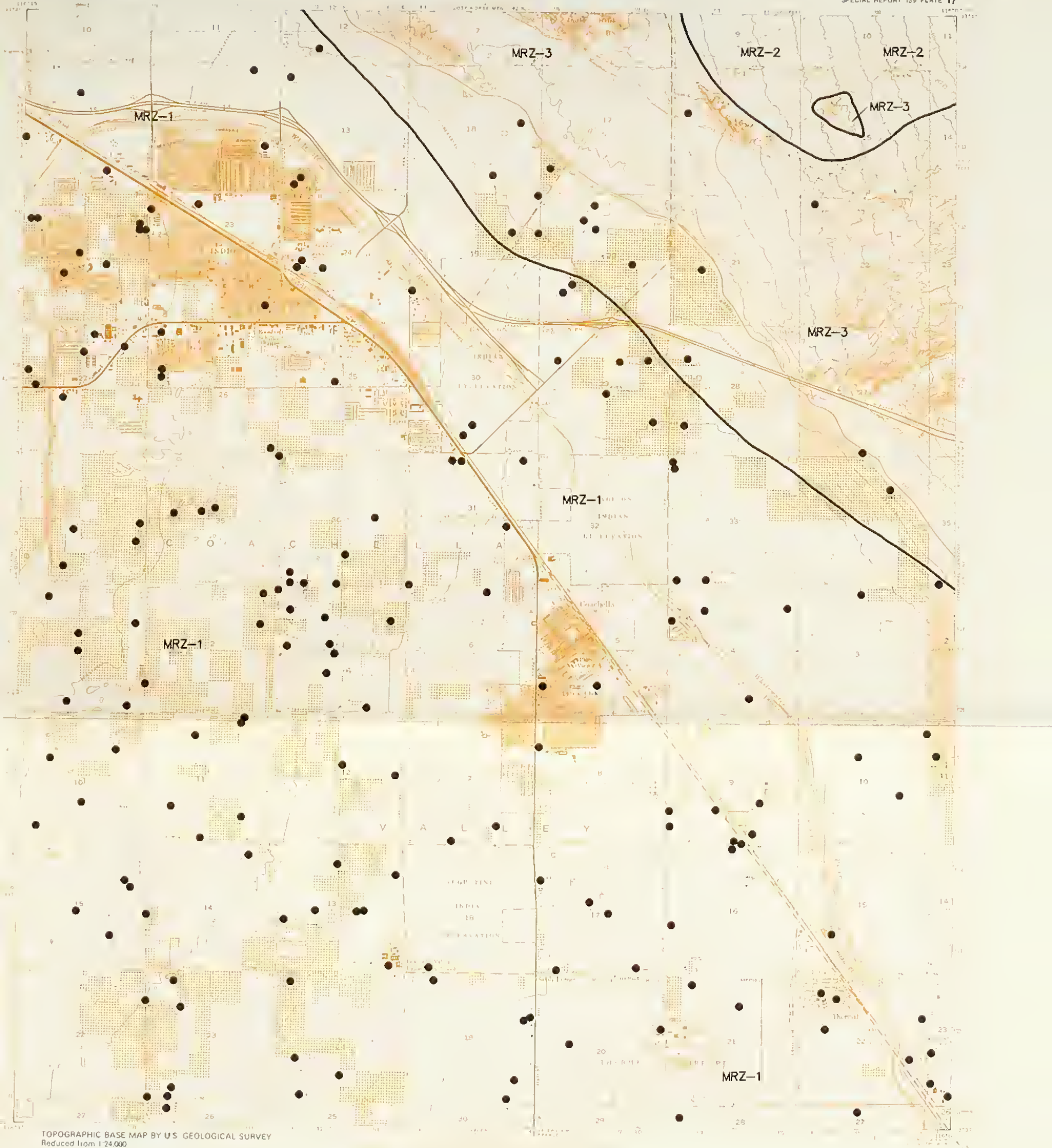


DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

INDIO QUADRANGLE

SPECIAL REPORT 159 PLATE 17



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
Planning and Research with modifications developed from
information supplied by local government and other sources

MINERAL RESOURCE ZONE BOUNDARIES

All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
Commodity name enclosed in parentheses

- MRZ-1 Areas where adequate information indicates that no
significant mineral deposits are present, or where it is
judged that little likelihood exists for their presence
- MRZ-2 Areas where adequate information indicates that
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MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
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1987

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RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

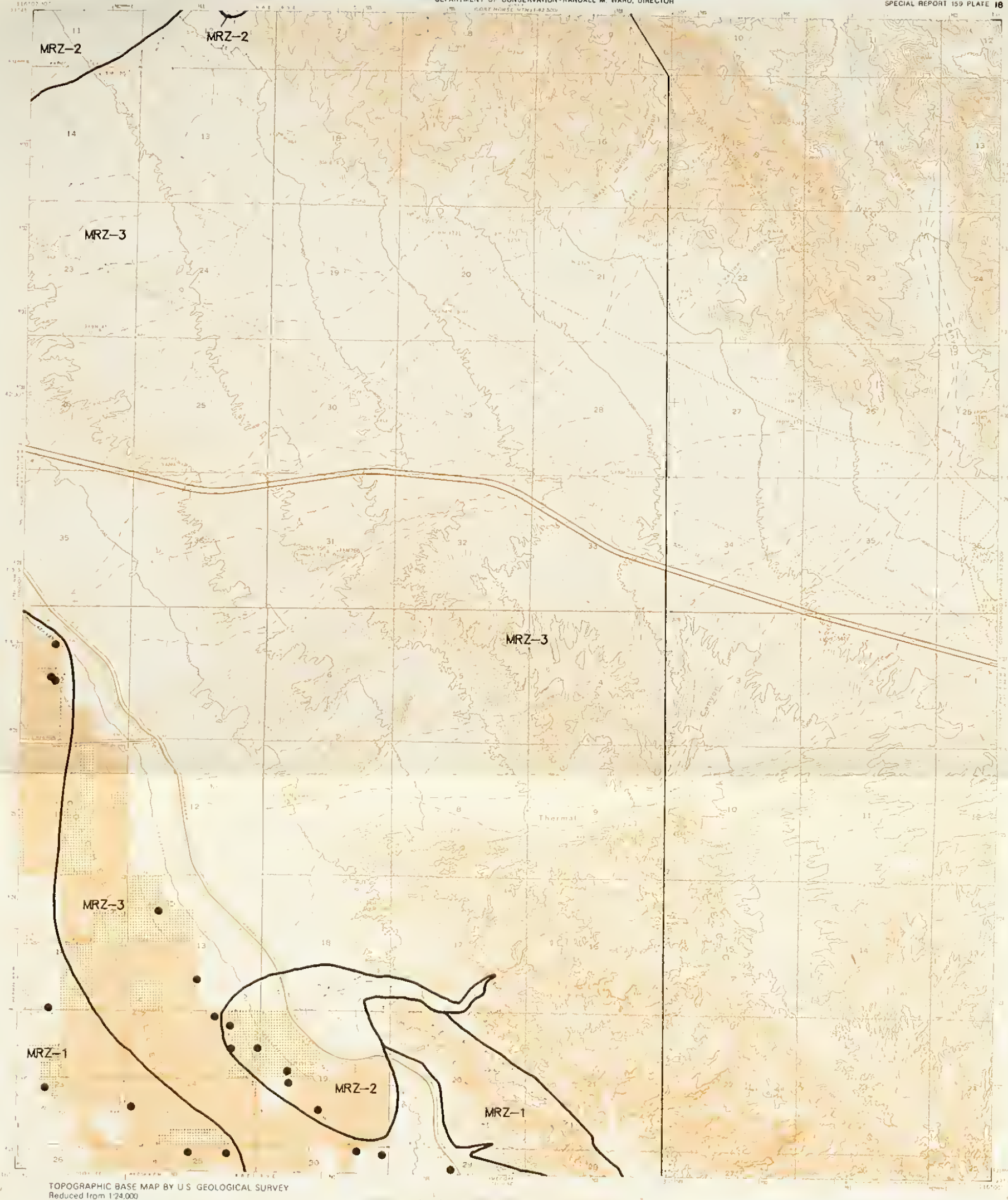


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STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

THERMAL CANYON QUADRANGLE

SPECIAL REPORT 159 PLATE 18



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY

Palm Springs P-C Region

By
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THE RESOURCES AGENCY - GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION - RANDALL M. WARD, DIRECTOR

MARTINEZ MTN QUADRANGLE

SPECIAL REPORT 159 PLATE 19

County of
Riverside

MRZ-2
(BASE)

MRZ-3

MRZ-1

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
ELEVATION IN FEET
VERTICAL DATUM: MEAN SEA LEVEL
HORIZONTAL DATUM: NAD 83

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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MINERAL RESOURCE ZONE BOUNDARIES
All Mineral Resource Zones are for Portland Cement Concrete
Grade Aggregate unless otherwise indicated by
Commodity name enclosed in parentheses

MRZ-2

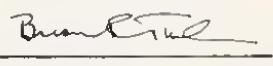
MRZ-1 Areas where adequate information indicates that no
significant mineral deposits are present, or where it is
judged that little likelihood exists for their presence
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See text for additional explanation of MRZ Symbols

MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
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1987

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VALERIE QUADRANGLE

SPECIAL REPORT 159 PLATE 20

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STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

MRZ-1
MRZ-3

MRZ-1

MRZ-1

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL: 10 FEET
ELEVATION: 100 FEET
SOURCE: U.S. GEOLOGICAL SURVEY

VALERIE, CALIF.

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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MINERAL RESOURCE ZONE BOUNDARIES

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Grate Aggregate unless otherwise indicated by
Commodity name included in parentheses

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significant mineral deposits are present, or where it is
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assignment to any other MRZ zone

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MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
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MECCA QUAD OF 10'E

SPECIAL REPORT 159 PLATE 21

STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
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DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

MECCA, CALIF

EXPLANATION

● DRILL HOLE

PRODUCTION-CONSUMPTION REGION BOUNDARY
AND OUTER BOUNDARY OF AREAS SUBJECT TO
URBANIZATION AND LIMIT OF AREA CLASSIFIED
Boundaries established from data supplied by the Office of
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MINERAL LAND CLASSIFICATION MAP AGGREGATE RESOURCES ONLY Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING AND
RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

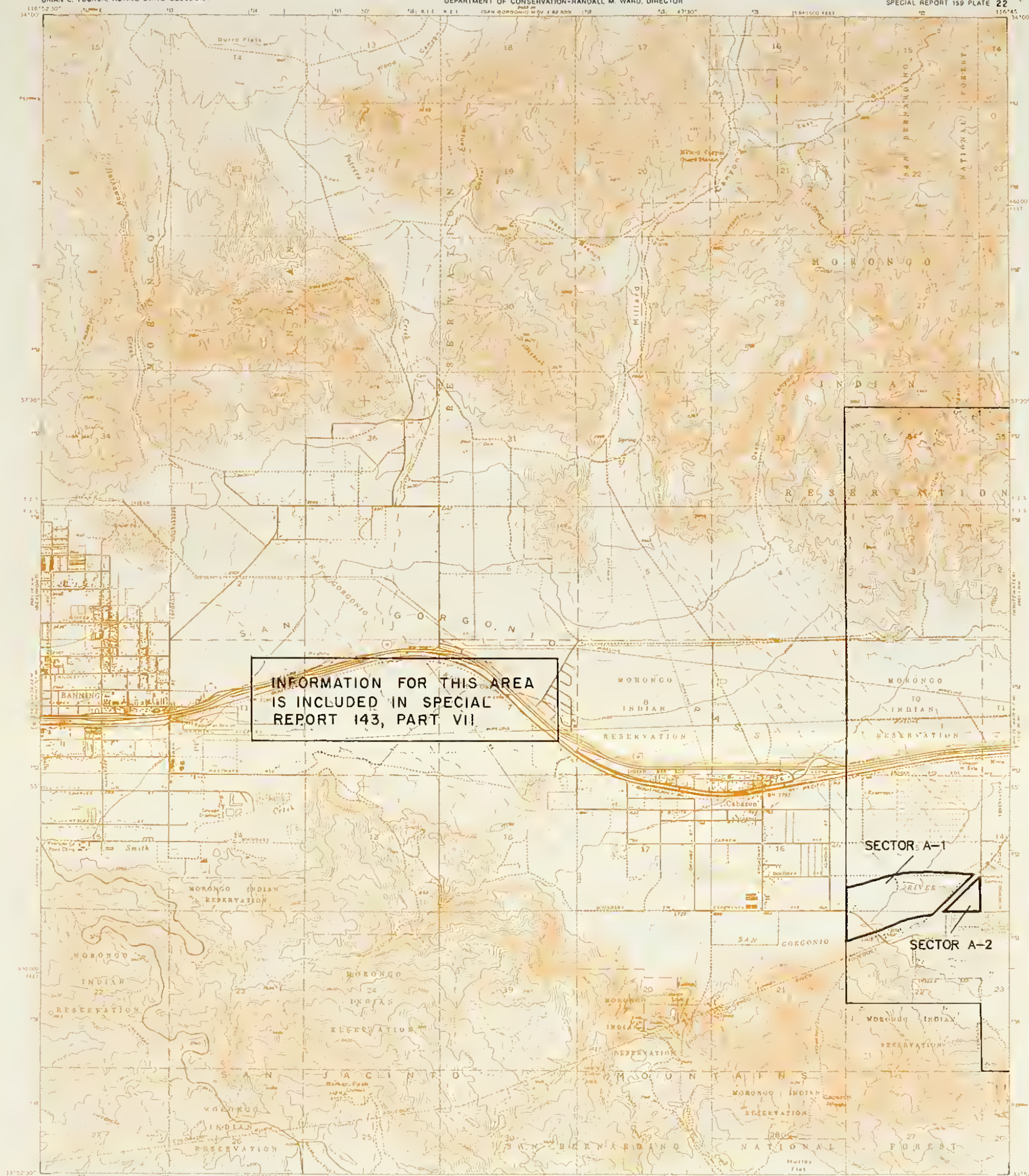


CABAZON QUADRANGLE

SPECIAL REPORT 159 PLATE 22

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BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
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DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000



CABAZON, CALIF

EXPLANATION



Sector boundary
Properties owned or
controlled by aggregate
producers



Aggregate Resource Sectors Palm Springs P-C Region

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Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY

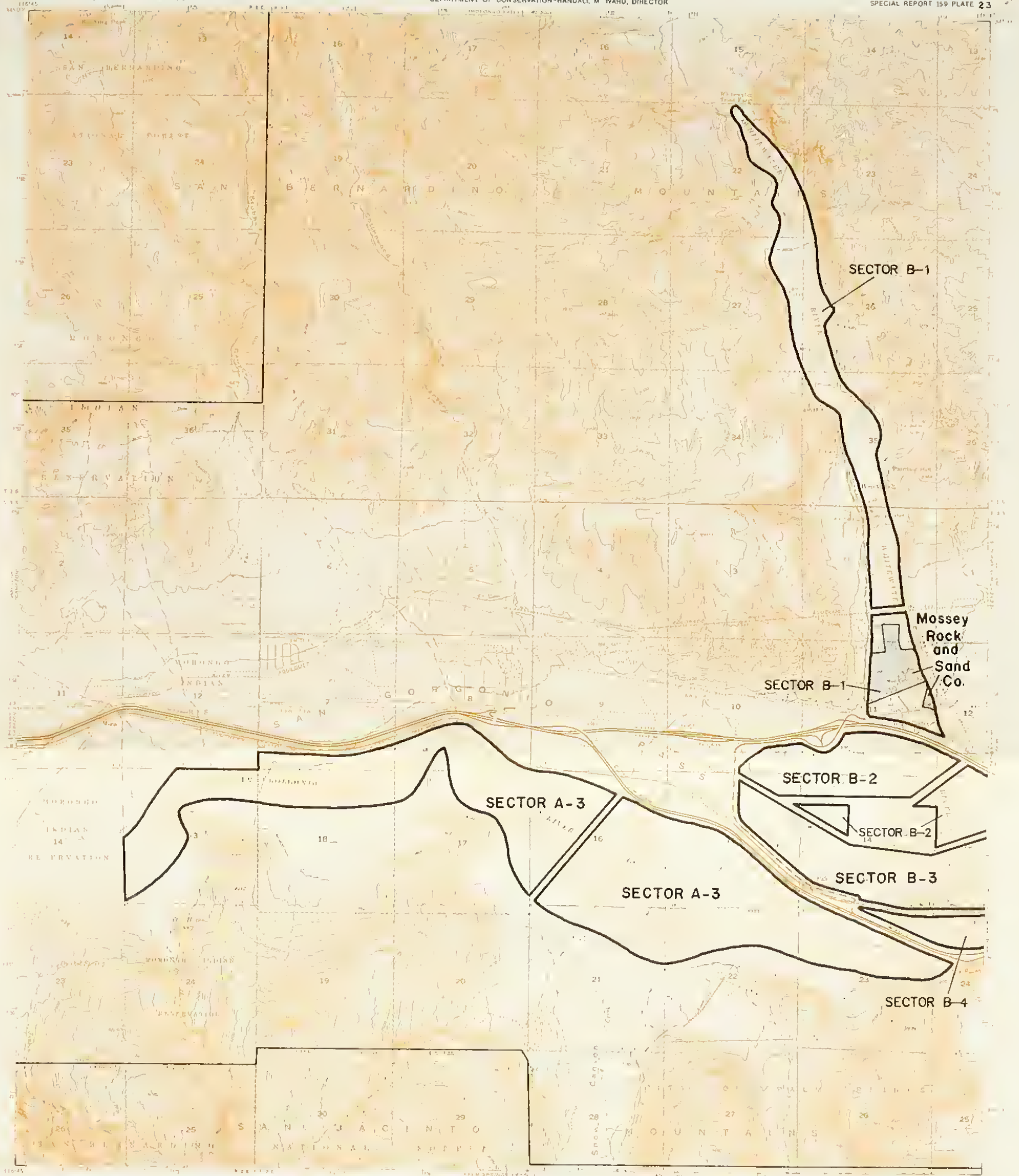


WHITEWATER QUADRANGLE

SPECIAL REPORT 159 PLATE 23

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

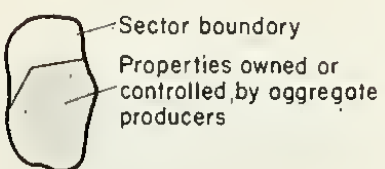
STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
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WHITEWATER, CALIF.

EXPLANATION



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AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

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ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY

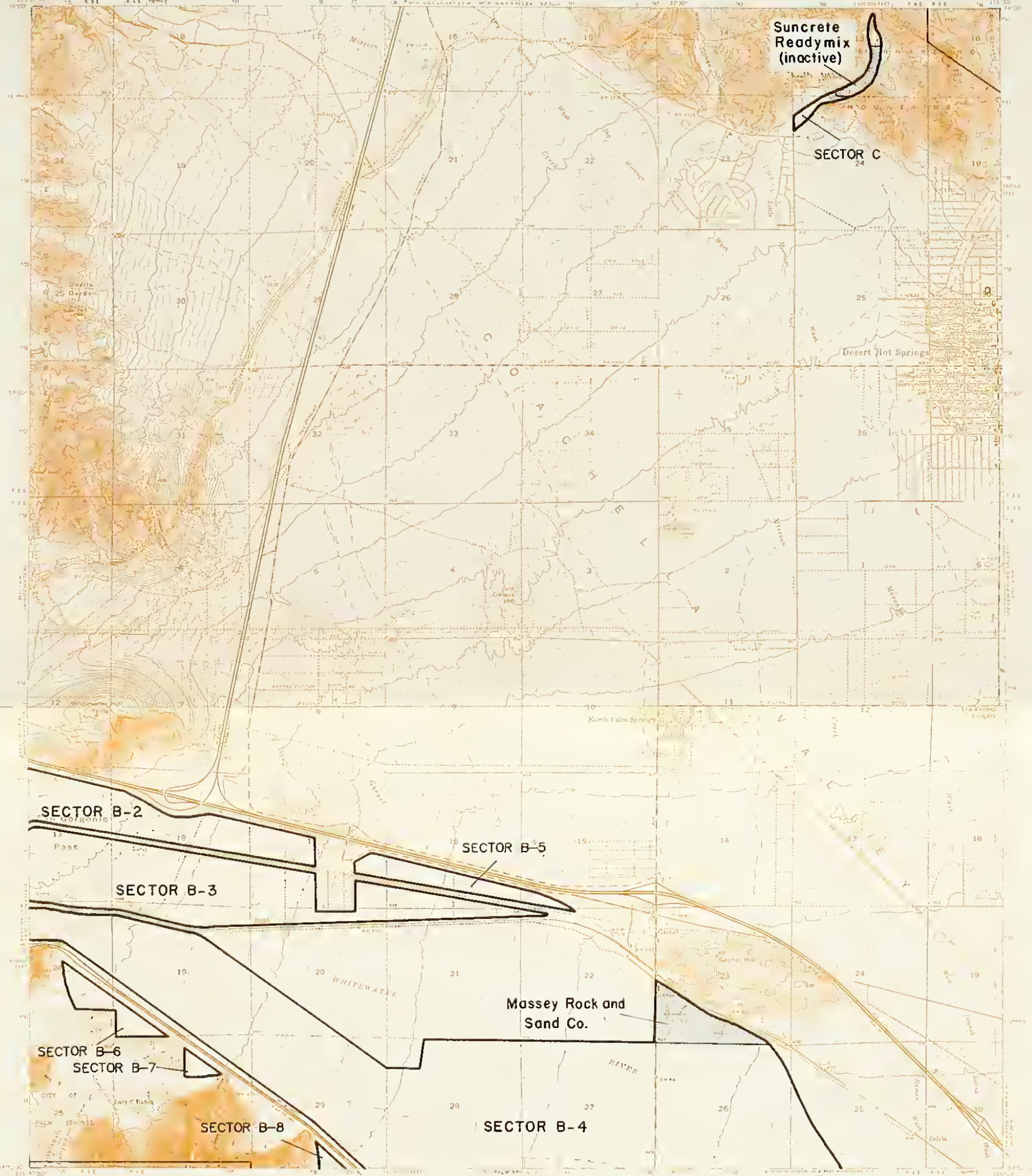


DESERT HOT SPRINGS QUADRANGLE

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

SPECIAL REPORT 159 PLATE 24

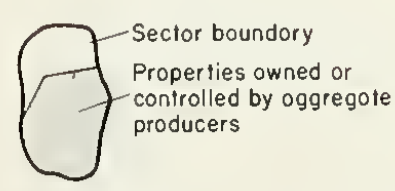


TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000



DESERT HOT SPRINGS, CALIF

EXPLANATION



Aggregate Resource Sectors
Palm Springs P-C Region

By
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AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

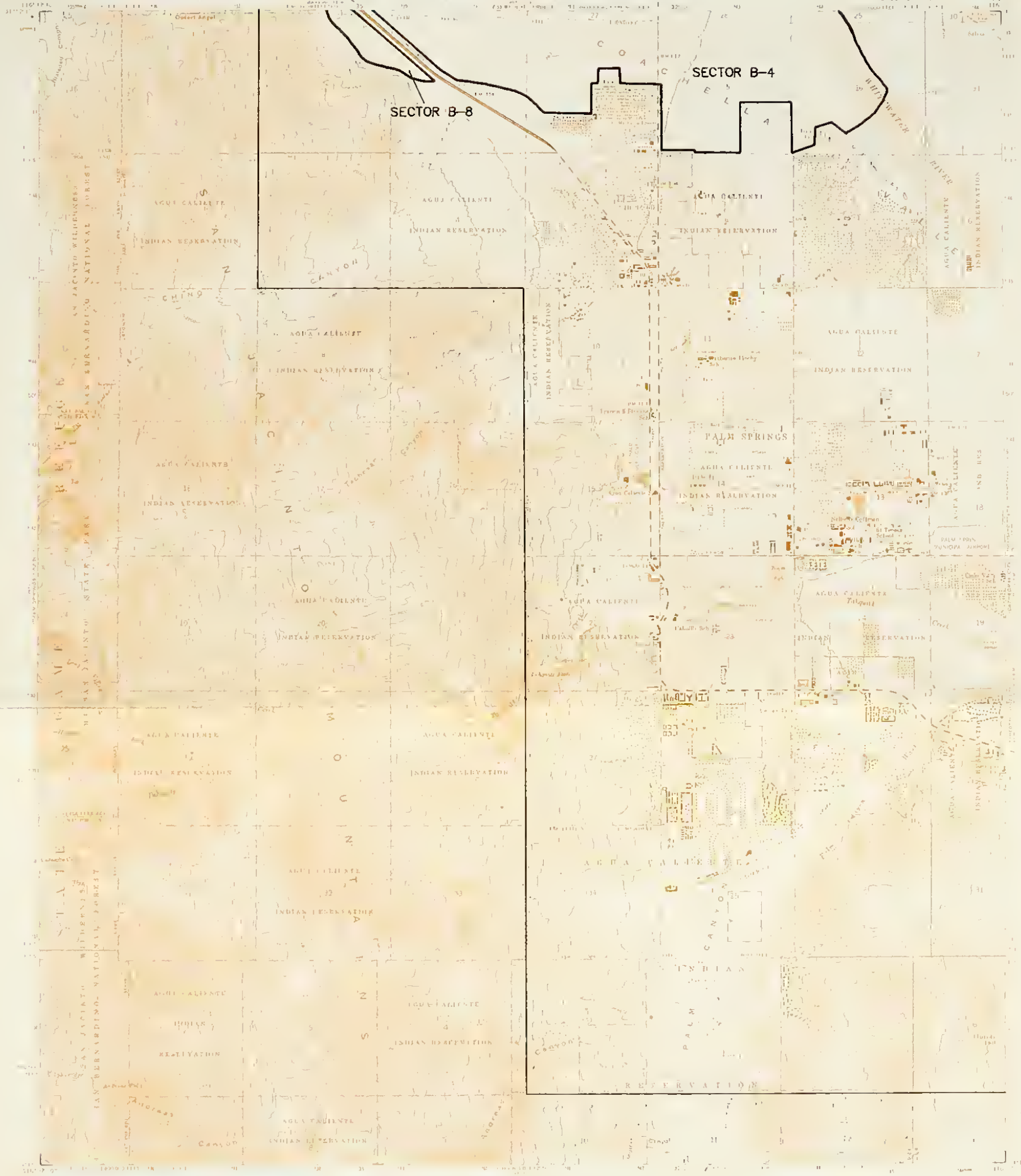
Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY



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STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

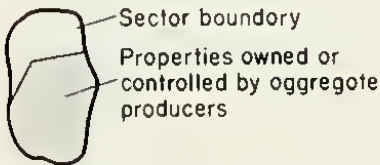


TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

NATIONAL ENGINEERING SURVEY

PALM SPRINGS, CALIF

EXPLANATION



Aggregate Resource Sectors
Palm Springs P-C Region

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Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY

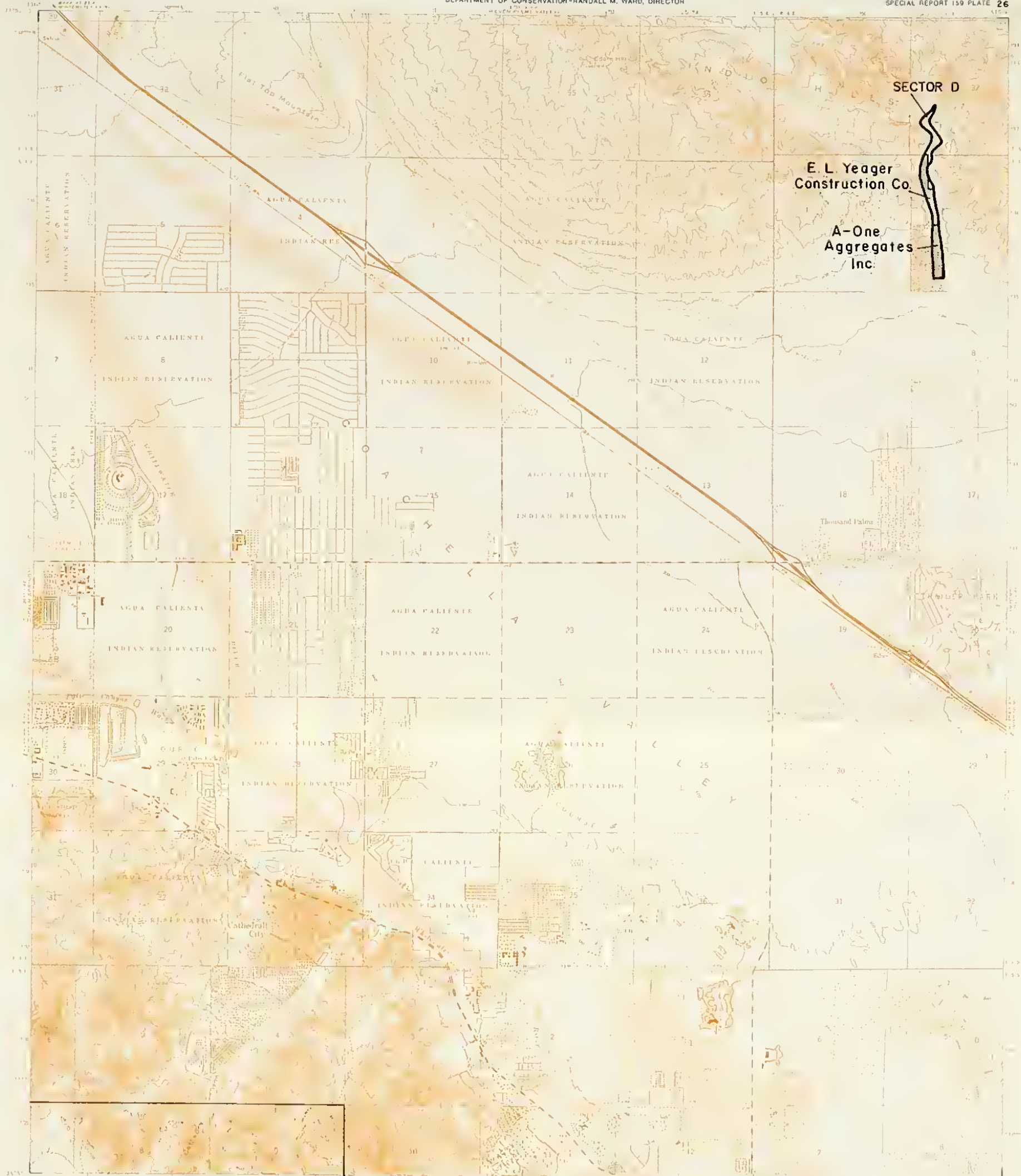


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BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-ORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

CATHEDRAL CITY OUAORANGLE

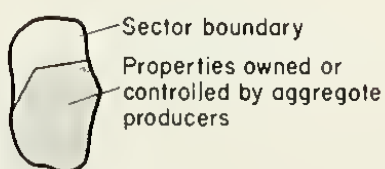
SPECIAL REPORT 159 PLATE 26



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Reduced from 1:24,000

CATHEDRAL CITY CALIF

EXPLANATION



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Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING
AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

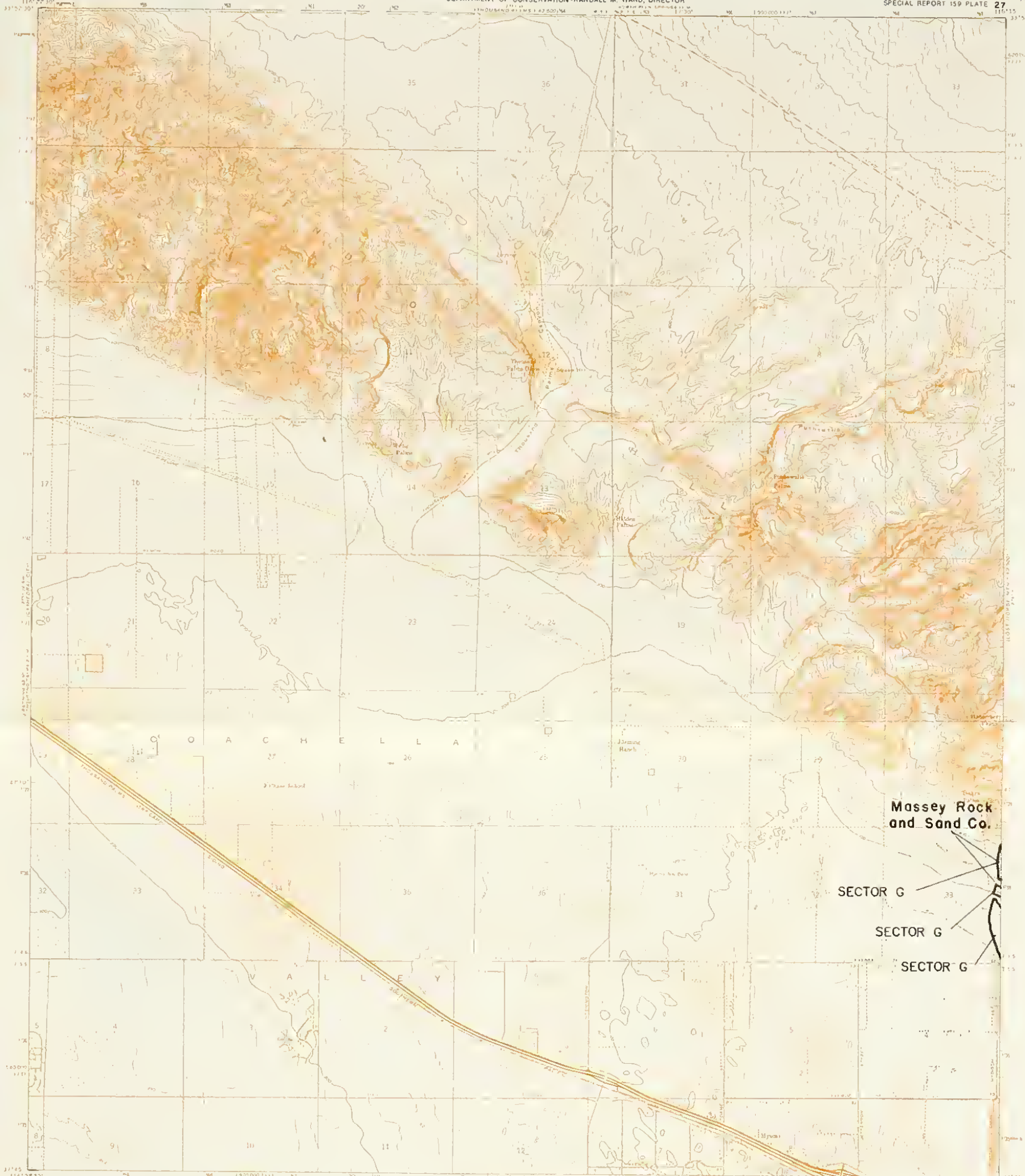
Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987



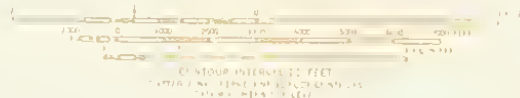
DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

MYOMA QUADRANGLE
SPECIAL REPORT 159 PLATE 27

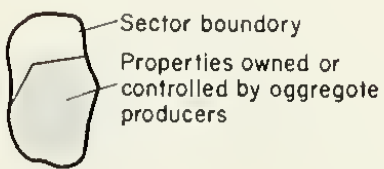


TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000



MYOMA, CALIF.

EXPLANATION



Aggregate Resource Sectors
Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING
AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

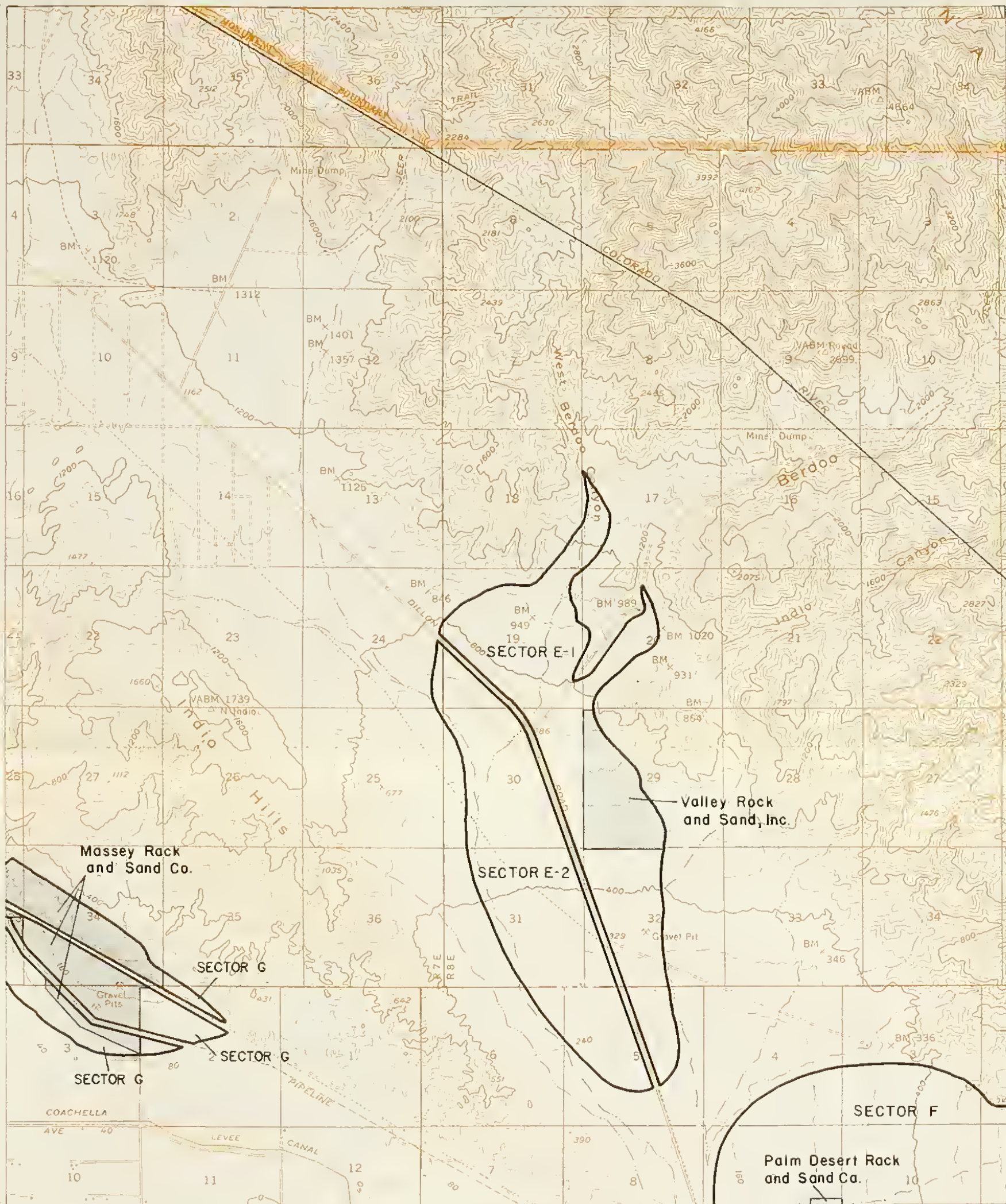


DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

LOST HORSE MTN SW 1/4 QUADRANGLE

SPECIAL REPORT 159 PLATE 28

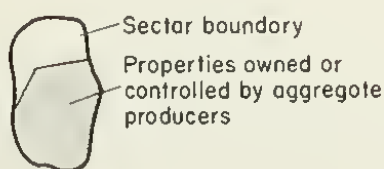


TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTOUR INTERVAL 40 FEET
NOT SHOWN WITH VERTICAL EXaggeration 10:1

LOST HORSE MTN SW 1/4, CALIFORNIA

EXPLANATION



Aggregate Resource Sectors Palm Springs P-C Region

By
Russell V. Miller
1987

PREPARED IN COMPLIANCE WITH THE SURFACE MINING
AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY



STATE OF CALIFORNIA-GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY-GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION-RANDALL M. WARD, DIRECTOR

LOST HORSE MTN SE 1/4 QUADRANGLE

SPECIAL REPORT 159 PLATE 29



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

CONTINU INTERVAL 40 FILE
 141 JNF GUCOCL 447124. UNIT ON 17.2

LOST HORSE MTN SE 1/4, CALIFORNIA

EXPLANATION



- Sector boundary
- Properties owned or controlled by aggregate producers



Aggregate Resource Sectors Palm Springs P-C Region

By
Russell V. Miller
1987

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AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 276I

PRODUCTION-CONSUMPTION REGION BOUNDARY

Bruce F. Tule
ACTING STATE GEOLOGIST JUNE 19, 1987



DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

INDIO QUADRANGLE

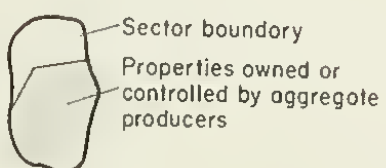
SPECIAL REPORT 153 PLATE 30



TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

INDIO, CALIF

EXPLANATION



Aggregate Resource Sectors Palm Springs P-C Region

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AND RECLAMATION ACT OF 1975, ARTICLE 4, SECTION 2761

Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

PRODUCTION-CONSUMPTION REGION BOUNDARY



THERMAL CANYON QUADRANGLE

SPECIAL REPORT 150 PLATE 31

STATE OF CALIFORNIA—GEORGE DEUKMEJIAN, GOVERNOR
THE RESOURCES AGENCY—GORDON K. VAN VLECK, SECRETARY FOR RESOURCES
DEPARTMENT OF CONSERVATION—RANDALL M. WARD, DIRECTOR

DIVISION OF MINES AND GEOLOGY
BRIAN E. TUCKER, ACTING STATE GEOLOGIST

SECTOR-F

Valley Rock and
Sand, Inc.

SECTOR H-1

SECTOR H-2

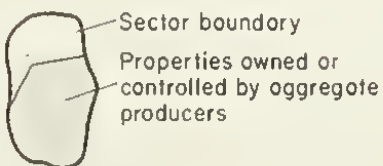
SECTOR H-3

Thermal

TOPOGRAPHIC BASE MAP BY U.S. GEOLOGICAL SURVEY
Reduced from 1:24,000

THERMAL CANYON, CALIF.

EXPLANATION



Aggregate Resource Sectors Palm Springs P-C Region

By
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1987

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Brian E. Tucker
ACTING STATE GEOLOGIST JUNE 19, 1987

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